August 18, 1958 PRICE 50 CENTS

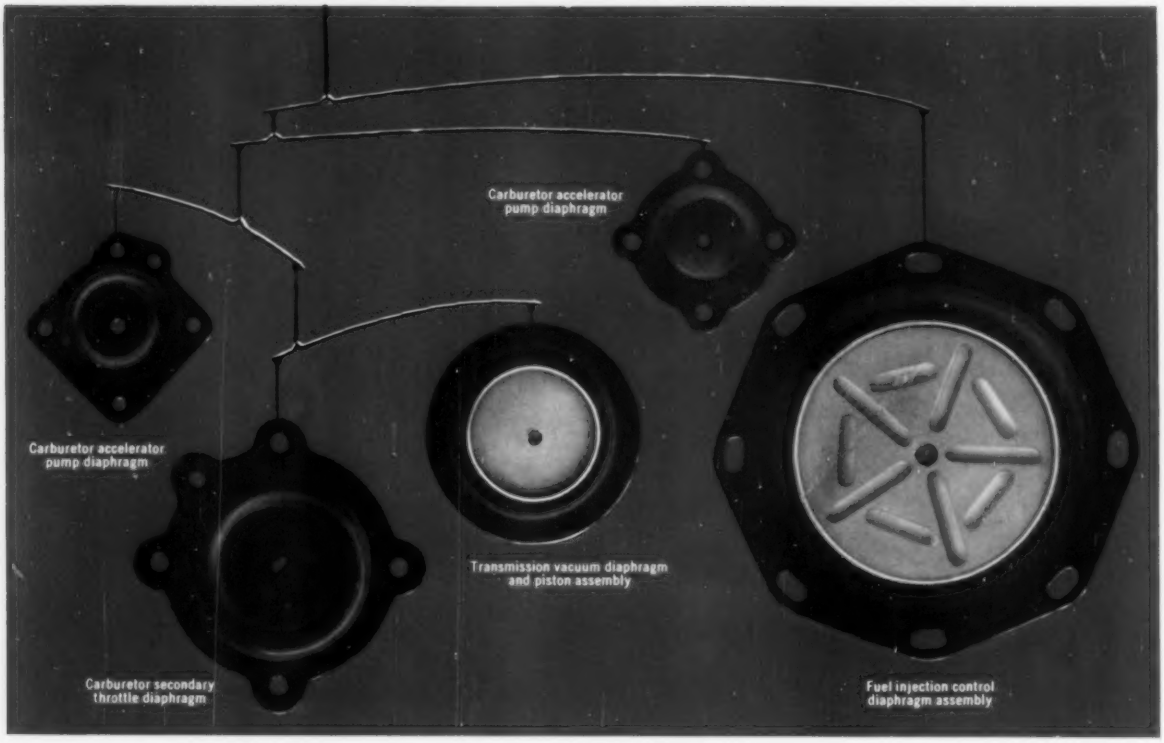
Product Engineering

McGRAW-HILL MAGAZINE OF DESIGN
RESEARCH AND DEVELOPMENT

DESIGN edition

TRANSISTORS
just 10 years old
page 5

INDUCTION MOTORS:
Rating, Duty Cycle, Enclosure


Carburetor accelerator pump diaphragm
Carburetor accelerator pump diaphragm
Transmission vacuum diaphragm and piston assembly
Carburetor secondary throttle diaphragm
Fuel injection control diaphragm assembly

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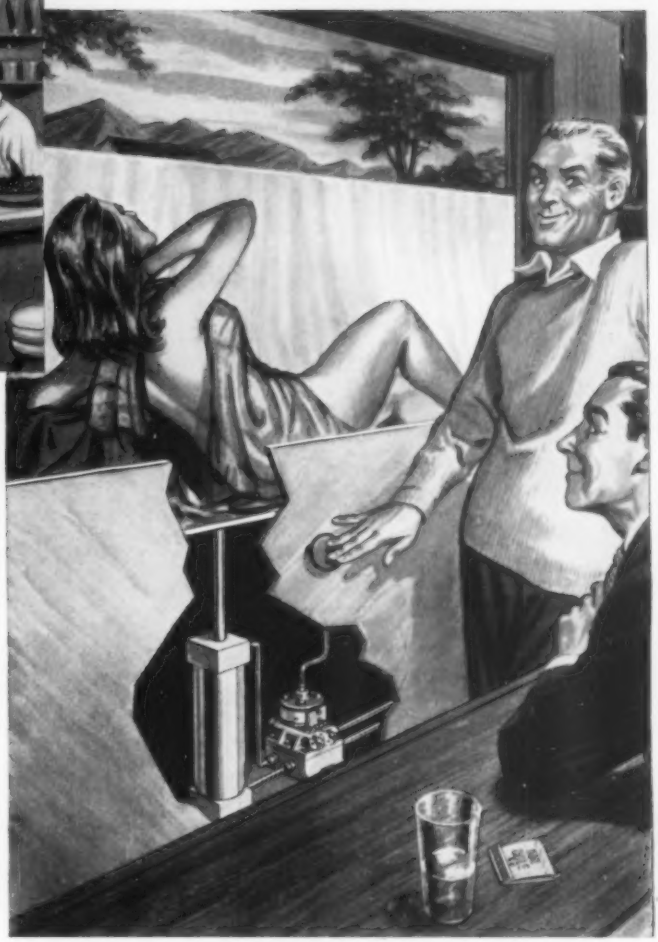


What! Painting or Etching to Suit the Occasion!

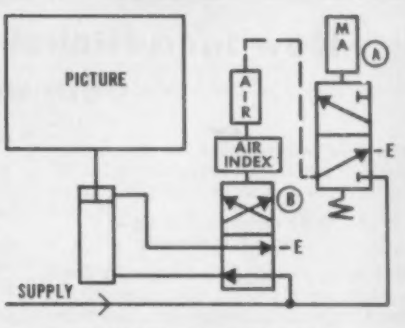
This "one knob picture control" is unlikely we will agree, but . . .

Art tastes do vary. The boys may not wish to share theirs with the spouses . . . in fact they may not *dare* to. And it might even call for a quick disappearing act for the little lady who is wearing little more than a blush. Unlikely as this device is, it would efficiently accomplish this neat scene change for such "art lovers." In the meantime, it gives us a chance to show something new. How one valve can now extend a double acting cylinder, letting it remain extended when the valve is released, then retract the cylinder at the next actuation by using the new Ross momentary air index adaptor.

The Ross air indexing momentary has hundreds of serious uses

Now, a standard Ross Skyline valve, either solenoid or air operated can include this momentary air index adaptor. Then the first actuation will send the valve one way and it will stay in that position, even when the actuator releases. The next stroke reverses the valve, again it stays after actuator release, etc.

See your Ross representative for application information.

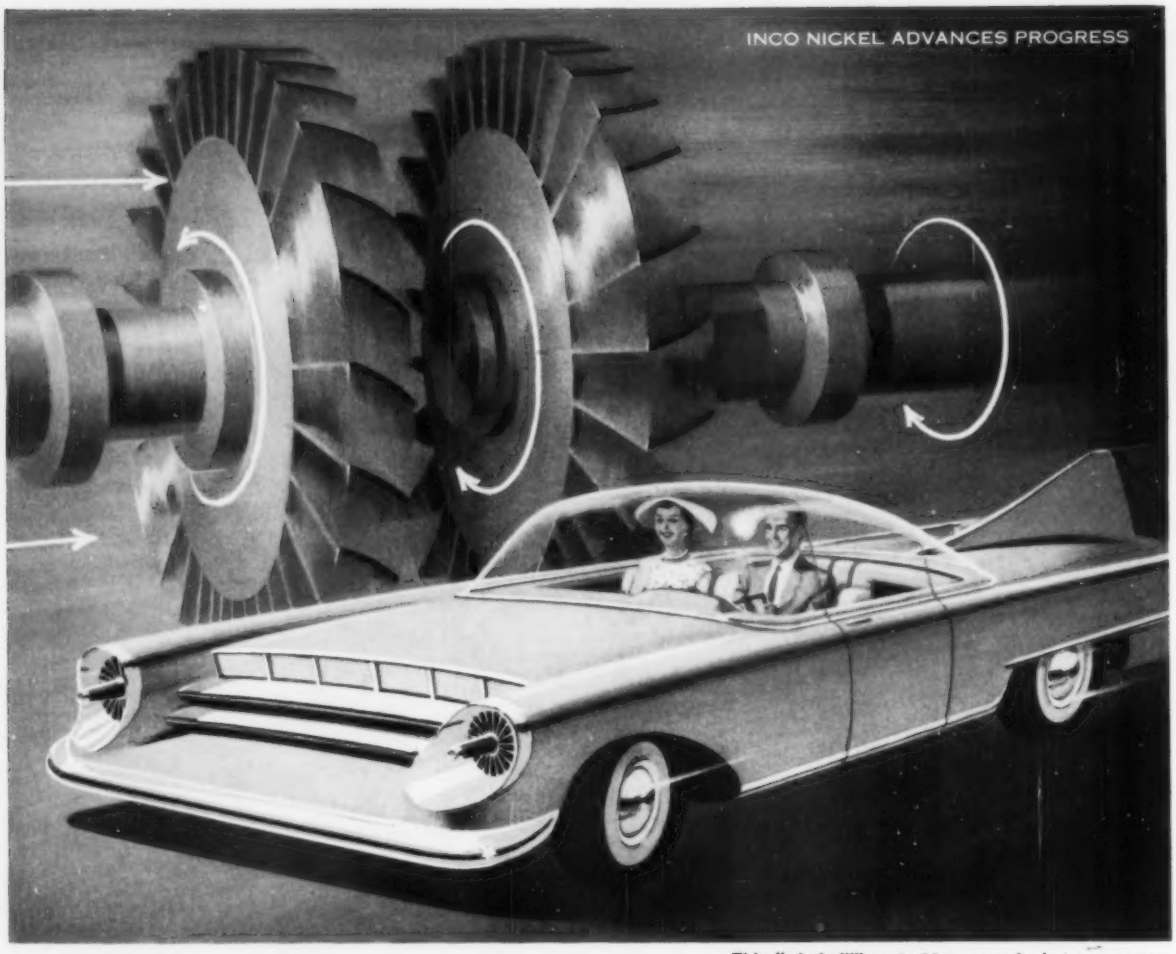


SEQUENCE OF OPERATION

1. Valve (A) is manually actuated, valve (B) reverses and stays put, keeping pressure on one side of double-acting cylinder.
2. When Valve (A) is manually actuated again, valve (B) reverses and stays put, keeping pressure on opposite side of double-acting cylinder.

ROSS OPERATING VALVE CO.

114 East Golden Gate • Detroit 3, Michigan



This "windmill" or turbine, spun by hot gas, powers the turbocar. For such a hot spot, designers depend on Nickel to help them solve heat-resistance problems.

How Inco Nickel is helping develop your new gas turbine car of tomorrow

It will be power-packed: the gas turbine engine in your dream car of the future. In tomorrow's trucks and buses, too.

Only one spark plug—runs on kerosene

This new, power-packed engine is much lighter, much smaller than yours. It has far fewer parts. No pistons. No water system. Only one spark plug. And it runs on lower-grade fuels like kerosene.

Not yet in production!

Before this dream car becomes a showroom reality, engineers have a number of big problems to solve.

One of the engineers' problems—the one Inco Nickel is helping with—is metals. *Heat-resisting metals!*

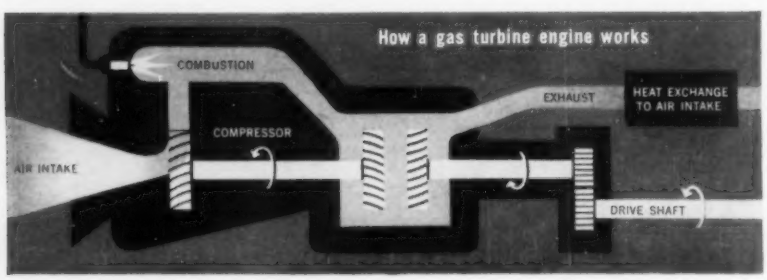
Gas turbine engines operate up to 1600 degrees F. These temperatures step up corrosion. So the job is to develop alloys that can carry the load—that resist corrosion—at these jet-high temperatures.

Nickel-containing alloys are just such metals

This has been proved by (1) International Nickel Company's *basic* research. By (2) the experience of jet engine designers. More proof comes from the research efforts of the automotive and aviation industries . . .

But the uses of nickel-containing alloys *are by no means limited to these industries.* There's a place for them in any field where heat, corrosion, stress and fatigue proves troublesome. Our new booklet, "High Temperatures Spur Use of Nickel-Base Alloys," points up this versatility. Write for a copy.

The International Nickel Company, Inc., New York 5, N.Y.



Inco Nickel

Makes metals perform better longer

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

AUGUST 18, 1958 Vol. 29, No. 33

Guide to Selecting Polyphase Motors* 58... C. C. Libby, Fairbanks, Morse & Co.
Before shopping for the motor, first consider the job it will have to handle. Here are tables matching driven-load characteristics with available motor designs . . . in terms of torque, slip and duty cycle.

Whip the Backlash in Spring Clutches* 62... Joseph Kaplan, Fairchild Camera & Instrument Corp.
These clutches are noted for unpredictable backlash—and it doesn't help to tighten spring tolerances. But here are two simple spring modifications that lick the trouble.

Design Features in New Products 64... Half truck, half tractor, it sprouts power take-offs; eccentricity for accuracy in close-tolerance machining; opposed flywheels give smoother feed stroke; tape holds gage to hundred-thousandths.

STAFF REPORT

Fluid Power for Machine-tool Controls 70... Franklin D. Yeaple, Jr., Associate Editor
The potential demand for improved control and actuation of machine tools is large—and will keep on growing. Author compares what different types of controls can offer.

Vacuum Gives Top-quality Metals 72... L. W. Johnson, General Electric Co.
By turning out purer, stronger castings, vacuum refining leads to reliable parts. But the processes differ in what they can do, so are compared here in a ready-reference chart.

Statistics for Better Specifications 75... H. R. Sheppard and H. Ginsburg, Westinghouse Electric Co.
The materials you need will be described precisely and at less cost by following the 3-step statistical procedure outlined in this article. Risk of rejects will be less too.

DESIGN FILE

10 Universal Shaft-couplings 80... Federico Strasser, Mankowitz and Strasser, Ltd.
These coupling tips follow 13 others given in Aug. 4 issue.

The Conjugate-beam Method 83... E. D. Clark, United Shoe Machinery Co.
Four examples accompany article that illustrates fast analysis of load problems.

DEPARTMENTS

Interesting to Note	5	New Components, Materials	87
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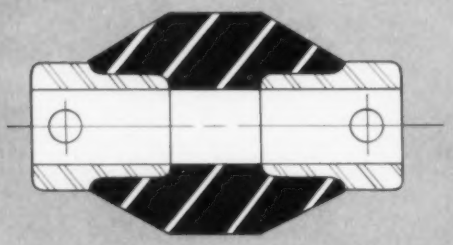
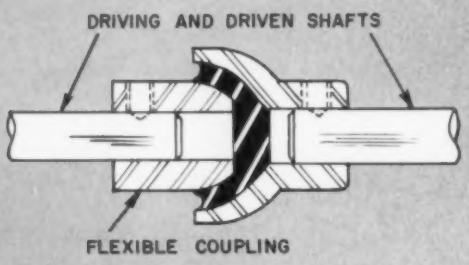
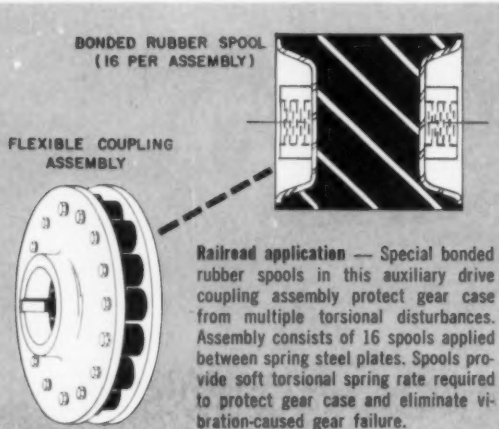
custom-designed LORD flexible couplings provide improved equipment performance



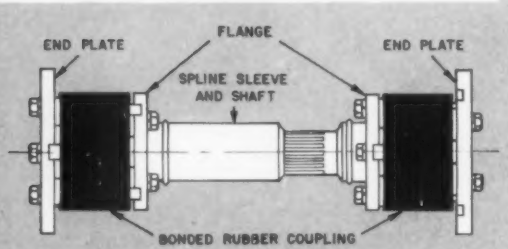
Business machine application — This coupling is uniquely applied in series of four pieces in gear train of business machine. Bonded rubber construction virtually eliminates noise transmission and accommodates shaft misalignment, assuring fast, accurate operation. Special elastomer contour imparts exact degree of torsional stiffness required.



Home appliance application — Special close-tolerance coupling transmits high motor torque in rugged washer-dryer application. Custom-compounded elastomer withstands high operating temperatures. Coupling accommodates 2° shaft misalignment, reduces noise and bearing wear.



Railroad application — Special bonded rubber spools in this auxiliary drive coupling assembly protect gear case from multiple torsional disturbances. Assembly consists of 16 spools applied between spring steel plates. Spools provide soft torsional spring rate required to protect gear case and eliminate vibration-caused gear failure.



Marine application — Custom-designed, non-magnetic coupling assembly, used on minesweeper main propulsion shaft, attenuates noise and accommodates shaft misalignment. Rated at 15,400 in.-lb. torque, it accommodates continuous misalignment of ¾" and momentary misalignment of 1¼" in all directions. Coupling is typical of high horsepower applications featuring optional fail-safe protection.

You will get optimum product performance with special Lord Flexible Couplings regardless of the specific requirements of your application.

Here are the performance benefits you can obtain. Efficient isolation of torsional vibration and shock. Accommodation of all misalignment—angular, parallel and axial. Smooth, quiet, constant speed transmission of power with no backlash. No lubrication or maintenance. Extreme overload protection. Long service life despite tough operating conditions. Torque capacities from inch-ounces to foot-tons.

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Interesting to Note . . .

The Transistor's Tenth Birthday

Early in 1940, Dr. Mervin J. Kelly, then Director of Research for Bell Telephone Laboratories, called a staff meeting to discuss work being done on semiconductors. During the course of the meeting, Russell S. Ohl, a staff member studying silicon, showed his fellow scientists a small chunk of black rock attached to which were wires leading to a voltmeter. When he allowed the beam from a flashlight to strike the black silicon, the instrument registered a voltage. Silicon had converted light to electrical energy, without a specially prepared surface. In fact the voltage was better than ten times that of an ordinary photoelectric cell.

"I didn't believe it," said Walter H. Brattain, recalling the experience. Yet his curiosity was aroused enough to study the silicon effect in his laboratory. Together with John Bardeen, Brattain developed the point-contact transistor which was announced publicly in the summer of 1948. Our cover shows transistors superimposed over germanium wafer slices.

The transistor has spanned in 10 years the development achieved by the electron tube in 40 years. While the 90 million semiconductors sold in 1957 had a dollar sales volume in excess of $100 million; the future is even brighter—output is expected to reach ½ billion units by 1965.

Don't Blame Statistics

Statistics have been used by some to prove that cigarets cause lung cancer; by others to prove that cigarets don't cause lung cancer. Some people will produce statistics showing business is awful; others will brandish another set of figures to show why times have never been rosier. Simeon Strunsky once said, "Statistics are the heart of democracy," and this may well be true. Figures are being used to prove everything from the dangers of atomic warfare to the best family tooth paste. But though some statistics can fool you, they can also be mighty helpful, as the article on page 75 points out.

It has been suggested that the origin of statistical theory began in a gaming hall in the midseventeenth century. The gambler Chevalier de Mere is supposed to have proposed to mathematician Blaise Pascal the following problem. Two men are playing cards. The first player getting a pre-set number of points wins.

(Continued on page 7)

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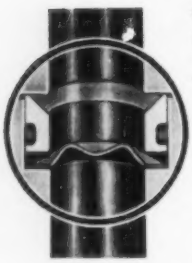
This is a re-design of our proven 250 P. S. I. air valve.

NEW LOW PRICE (*the result*) FACE LIFT (*the reason*)



None of the operating advantages of this rugged *'Shear-Seal'* valve has been reduced one iota!

. . . same non-corrosive construction throughout — eliminates failures due to rust.

. . . same long wearing leak-proof qualities — metal to metal *'Shear-Seal'* design is not sensitive to dirt, compensates for wear.

. . . same installation savings — because no oilers or filters are needed.

Only the exterior has been modified — tailored to the special preference of the Original Equipment Manufacturers — and, as a result, costs and prices have been substantially reduced.

Write for bulletin 5000 which includes design specs.

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barksdale valves

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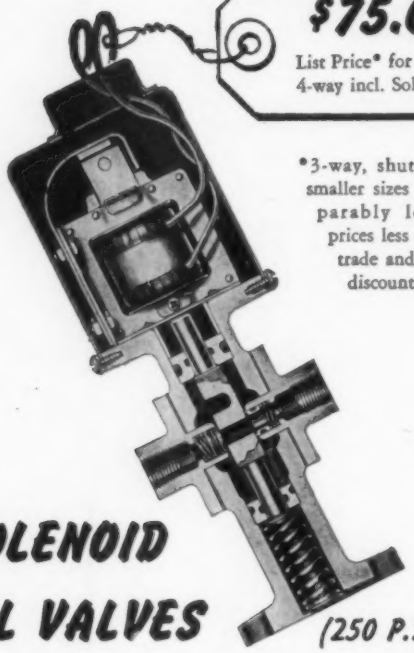
LEAKPROOF (SHEAR-SEAL)

$75.00
List Price* for a ½" 4-way incl. Solenoid

*3-way, shut-off and smaller sizes are comparably less. All prices less the usual trade and quantity discounts.



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WHERE	WHY	HOW
Thread rolling machines	Holding position (leakproof)	Lapped sealing surfaces seal tight indefinitely as a result of wear compensation
Pressure testing in automotive production	Oil gets contaminated by scale in castings (not critical to dirt) reduced maintenance	Sealing surfaces in constant, intimate contact, dirt can't lock valving members – saves coil burn-out
Hydraulic work feed apparatus	(Leakproof) . . . as versus spool valves which cause overdemand on hydraulic system	Positive shut off of internal port to port leakage and of course, no external leakage
Machine tool chucking & clamping	Maintaining safe holding pressure (leakproof)	Saving auxiliary equipment such as pilot operated check valves
Automatic door openers	Quick action (high flow capacity)	No spools or poppets obstructing full, round flow passages
Solenoid controlled hydraulic system on machine you build	Better performance Lower manufacturing costs Reduce service problems	Shear-Seal valves have full flow, are leakproof, not sensitive to dirt Low priced, less auxiliary equipment and labor cost. Valves don't stick, saving coil burn-out; stay leakproof indefinitely, seals are wear compensating

Write for Catalog 58-59

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They are forced to stop play before the game is completed. Given the number of points each player has won, how should the stakes be divided? Pascal considered the problem and wrote a friend, Fermat, asking his advice. The correspondence between the two men led to the beginnings of Pascal's mathematics of probability around which statistical theory is based.

Poison Basin

Around the turn of the century, a sheepherder on the vast plains of southern Wyoming led his flock into a large green basin to graze. Within several hours, the rancher noticed that many of the animals were walking uneasily as if intoxicated. Soon several of them went into convulsions and died. Others followed; by evening, the rancher not only lost his entire flock, but his horse as well. News of the disaster spread quickly and that basin has since earned the name—Poison Basin.

It wasn't until the mid-30s that a research chemist from the University of Wyoming was able to discover the cause of death in Poison Basin. The plants on which the animals had been feeding had the property of drawing the element selenium from the soil and storing it in their leaves. Further investigation showed a tie-in between selenium deposits in the soil and the abundance of this particular milky plant. For years selenium was of serious interest only to sheep and cattlemen, then in the late '40s it was found to be useful as a catalyst in alloying steel. One of its applications today is in rectifiers that change ac to dc for dc motors and controls.

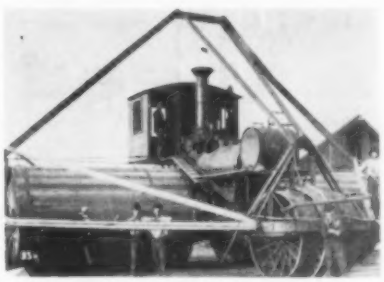
In selecting a motor, its current, torque, and speed are major considerations, as discussed on page 58.

America's First Ironworks

When America was first colonized, the most prized possessions of every housewife was her supply of pots and pans. Some, black with soot, handed down by her grandparents; others newly purchased before coming to the new land. In the town of Hammersmith (now Saugus, Mass.), a group of merchants banded together and decided that what their colony needed was its own source of supply for bed warmers, cooking ware, nails, bolts, chisels, plowshares and arms. Fortunately, Hammersmith was on the water, making its wares accessible not only to local residents but to a world market too.

With an eye to international trade these merchants organized America's first ironworks in 1646 with an initial capital of $165,000, and within four years were in full production. Using seven waterwheels to turn gears, rollers and slitters the plant could produce about a ton of iron a day from its 21-ft granite blast furnace. Under the guidance of blacksmith Joseph Jenks, the mill employed 80 men at an average wage of 12¢ an hour for a 12-hour day. Since severe winters limited operations to 180 days a year, business was not as good as expected and the ironworks lasted only 20 years. Although a far cry from the steel mills of today, employing such vacuum casting techniques as described on page 72, the 300-year-old ironworks is now back again—restored down to the last detail and open for public inspection.

When Best's Machine Was Best



Moving a boulder to widen a cave or digging a hole to trap an animal was man's first encounter with construction. Later, Pharaohs wanted monuments like the Great Pyramids and hordes of men spent a lifetime attempting to complete the task. The evolution of construction equipment was limited for centuries by the technological abilities of men.

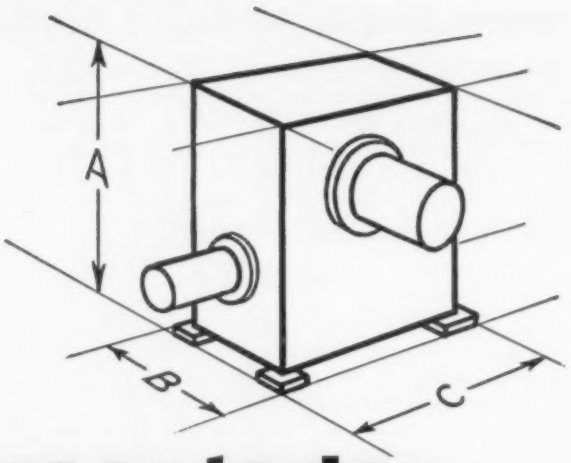
Came the industrial revolution and the development of the steam engine–and earthmoving equipment began taking on a new appearance. In 1889, Daniel Best, an easterner who migrated west, built a mammoth steam-powered tractor. It looked like a steam locomotive, with two 15-ft-long rollers bulging from each side. Each roller was 9 ft in diameter and the entire machine weighed better than 20 tons. It soon found its place harvesting grain. When another easterner-moved-west, Benjamin Holt, entered the steam tractor business in 1896, Best built a gasoline-engine tractor and spread word that the steam tractor was old-fashioned. To prove his point he promised to stage a tug of war between a gasoline tractor and a steam tractor.

The main street of San Leandro, Calif., was lined with curious onlookers the day of the contest. Some who had bought steam tractors felt gypped; some were against any "new-fangled" machinery, content with a horse and plow; others were just curious. According to the local paper it was a quick contest: "The new model hauled the steam engine around the block."

Holt, hurt by the Best demonstration, developed and patented the first crawler tractor in 1906 and was again back in business. Competition among tractor companies is just as keen today. Page 64 describes a new entry—Daimler-Benz' Unimog, which not only works around the farm but also doubles as a truck. What about Best and Holt? In 1925 they joined forces . . . keeping Holt's famous trade mark, Caterpillar.

—Benedict A. Leerburger Jr.

Do-It-Yourself...



Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

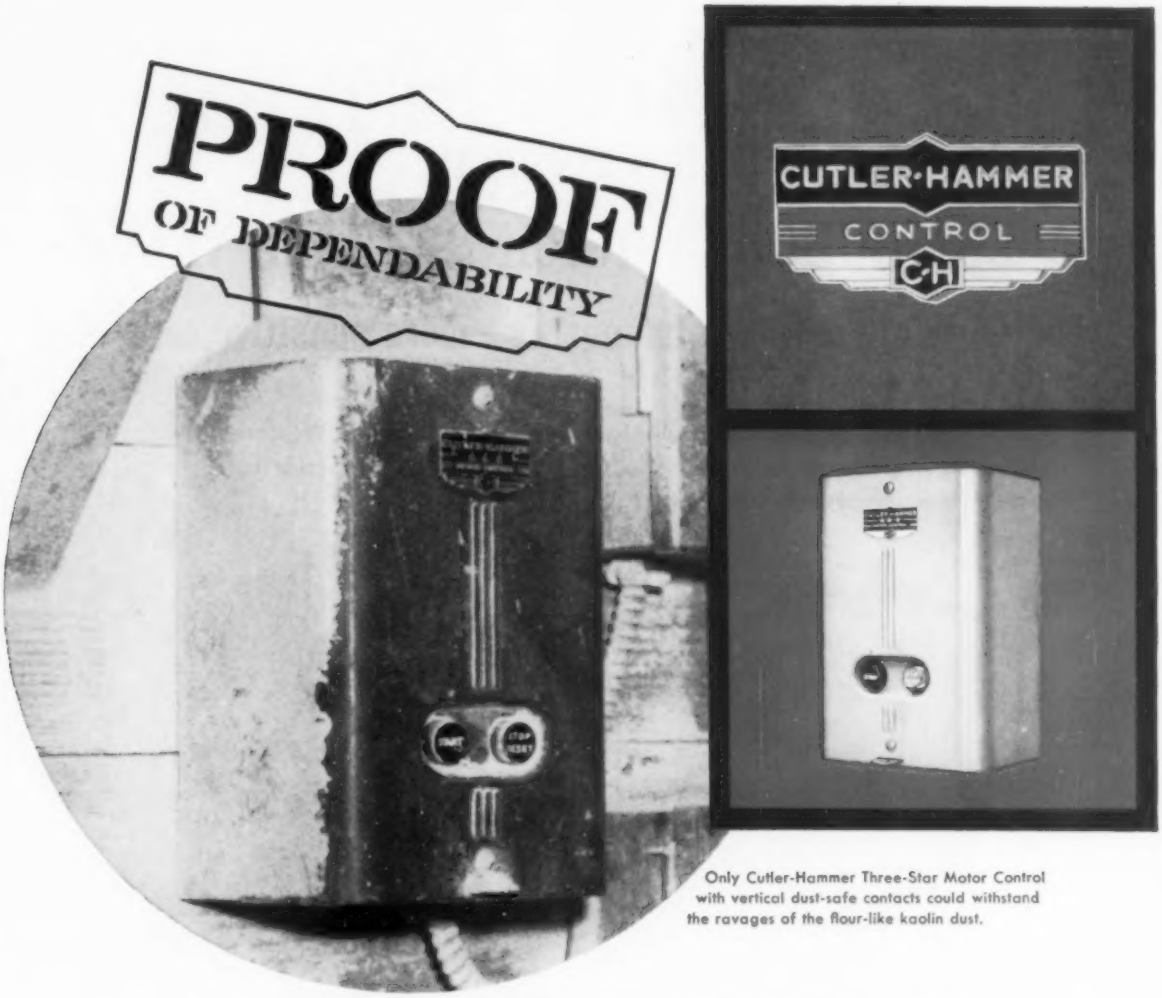
Does this reduce load capacity? No sir! You can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

Cone-Drive Gears, that's where!

Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.



Only Cutler-Hammer Three-Star Motor Control with vertical dust-safe contacts could withstand the ravages of the flour-like kaolin dust.

Large Southern kaolin processing plant cuts maintenance costs with Cutler-Hammer Control

By the very nature of the product, kaolin processing is an extremely dusty operation. Because of this the electrician at a large Southern kaolin plant found it necessary to replace the dust-fouled contacts in the motor starters every 30 to 60 days. Several makes of motor control were tried, but the results were always the same . . . dust laden contacts wore rapidly requiring frequent attention.

Thirteen months ago a Cutler-Hammer Three-Star Magnetic Starter with vertical dust-safe contacts was installed, and the electrician reports perfect operation without a single contact replacement . . . no time lost for repairs.

This is positive proof of dependability . . . proof that Cutler-Hammer Three-Star Motor Control works better, lasts longer than any other on the market today. Why take chances with costly production interruptions? Order dependable Cutler-Hammer Three-Star Motor Control from your nearby Authorized Cutler-Hammer Distributor today. For complete ordering information, write for the Cutler-Hammer Merchandiser, EA-100-R249. CUTLER-HAMMER Inc., Milwaukee 1, Wisconsin.

CUTLER·HAMMER

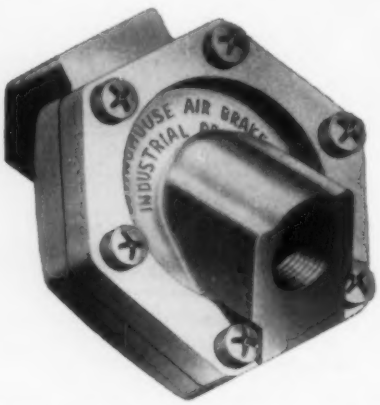
Cutler-Hammer Inc., Milwaukee, Wis. *Division:* **Airborne Instruments Laboratory.** *Foreign:* **Cutler-Hammer International, C. A.**
Associates: Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation, Inc.

New Product Announcement

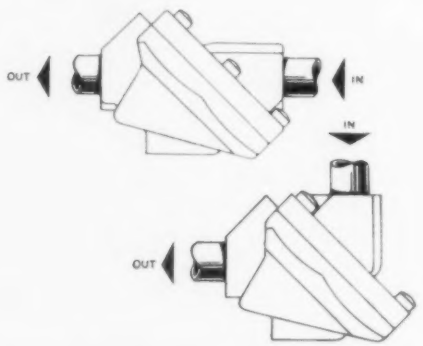
WESTINGHOUSE QUICK RELEASE VALVE

light weight...flexible mounting...more sensitive control

Here is the new Westinghouse Quick Release Valve. Its all-new design features a number of improvements which make it the most efficient device you can use to vent air-pressure cylinders and other pneumatic equipment.



Only 7 ounces!—The Westinghouse Quick Release Valve is made of aluminum—it weighs only seven ounces. It is ideally suited to meet installation requirements where weight is an important factor.



No bracket needed—A key feature of this valve lies in the flexible mounting of its supply port, allowing the inlet and outlet ports to be assembled on the same center line or at right angles to each other. In addition, you need no bracket to install the new Westinghouse Quick Release Valve.

Unmatched response—This new device provides one of the most sensitive controls yet offered in a valve of this type. Because of its design, the Westinghouse Quick Release Valve will respond to pressure changes as low as 6 psi.

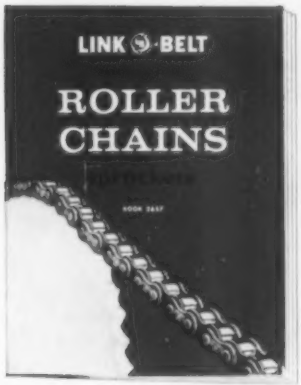
Other advantages—Westinghouse Quick Release Valves have larger internal passages, allowing them to exhaust greater volumes of air quickly and efficiently. These valves have been engineered so that centrifugal force will not affect their performance when mounted on rotating or revolving devices. Constructed of sturdy, corrosion-resistant aluminum, these valves will deliver long, trouble-free performance with minimum maintenance. The diaphragm of the Westinghouse Quick Release Valve is oil-resistant and its special design provides quiet operation.

To speed the operation of any pneumatic circuit, order the new Westinghouse Quick Release Valve from your local distributor. Price: $5.25. Quantity discounts available.

See the yellow pages under Cylinders for the name of your local distributor.

Westinghouse Air Brake
COMPANY
Industrial Products Division
WILMERDING PENNSYLVANIA

NEW roller chain engineering data book



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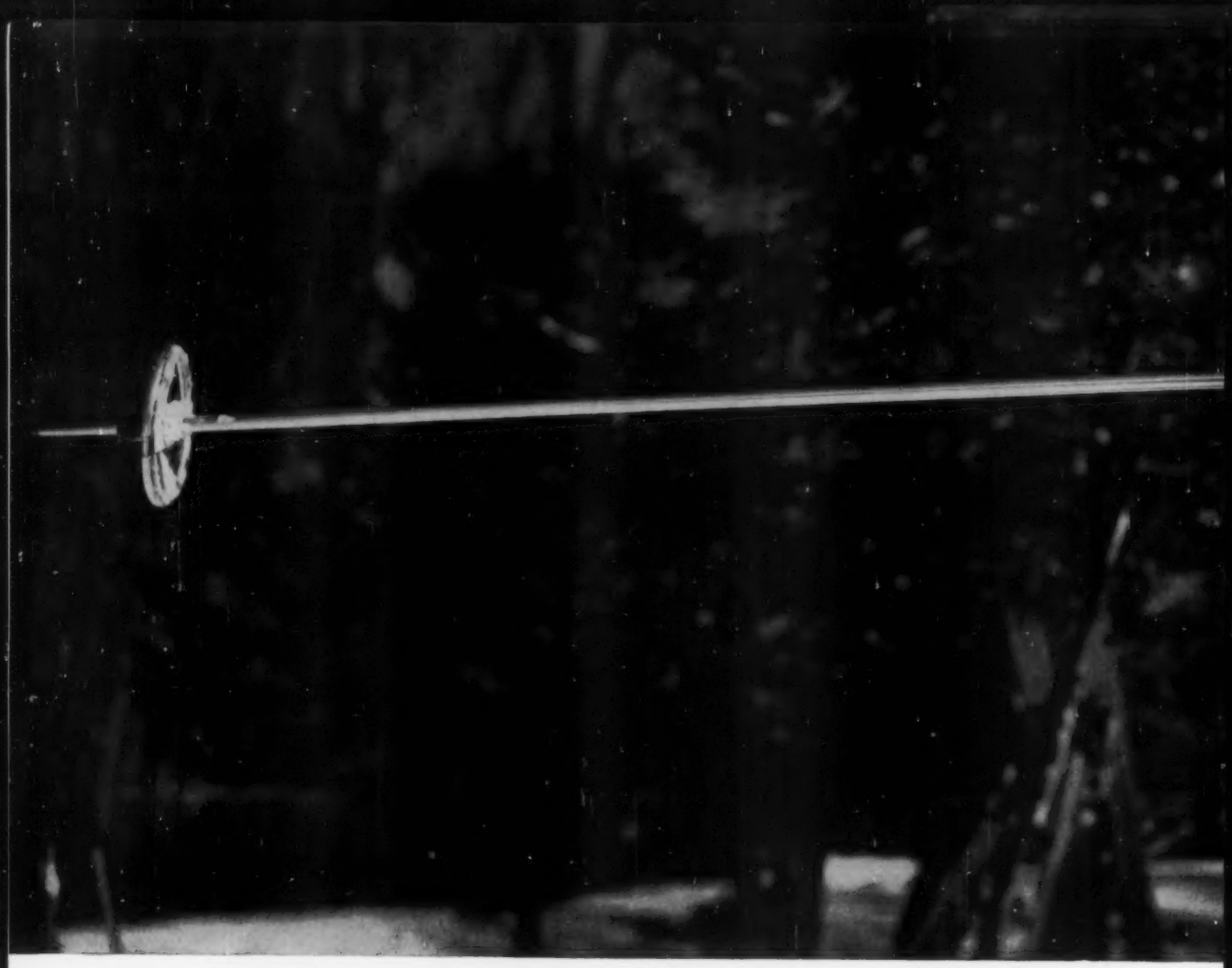


Lightness—There are a few products in this world that you don't want to be light—like pile drivers, dumbbells and paper weights. But generally speaking, every designer strives for the lightest product that will do the job, especially in things like truck trailers and off-highway earthmoving equipment (the lighter the unit, the greater the load capacity) and in structures like a bridge, which has to support itself *and* a roadbed.

Lightness is easy to attain. For instance, you could make a ski pole out of balsa wood, rather than the Stainless shown above, and never know you were holding it. But almost always as we strive for lightness, we also demand a certain amount of stiffness, ductility, strength. More than that, we need a material that can be fabricated on high-speed machinery.

So it's interesting to note that today, in cases where lightness is absolutely vital and *hang the cost*, designers still turn to steel rather than costlier materials when they need low weight and high performance.

When our Explorer I satellite screamed into outer space, it was cased in Stainless Steel. On every high-performance aircraft, the landing gear is made from ultra-strong steel because each single pound shaved from the landing gear assembly saves from 7 to 10 pounds of total aircraft weight, since it reduces the wing area, thrust and fuel required for the specified performance. Today, as we prepare for the first exospheric manned flight, we are completely sheathing the fuselage in steel, because no other available material has a better combination of lightness and high temperature strength.

In new, light-weight bridges, designers automatically think in terms of the new alloy and high strength steels. They're so strong that thinner, lighter sections can be used, and they have the extra atmospheric corrosion resistance necessary.

The new steels should be chosen and fabricated with care, and the final selection should be made by a skilled metallurgist—either on your staff or ours. United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
Tennessee Coal & Iron • United States Steel Supply • United States Steel Export Company

USS United States Steel

STEELS FOR DESIGN

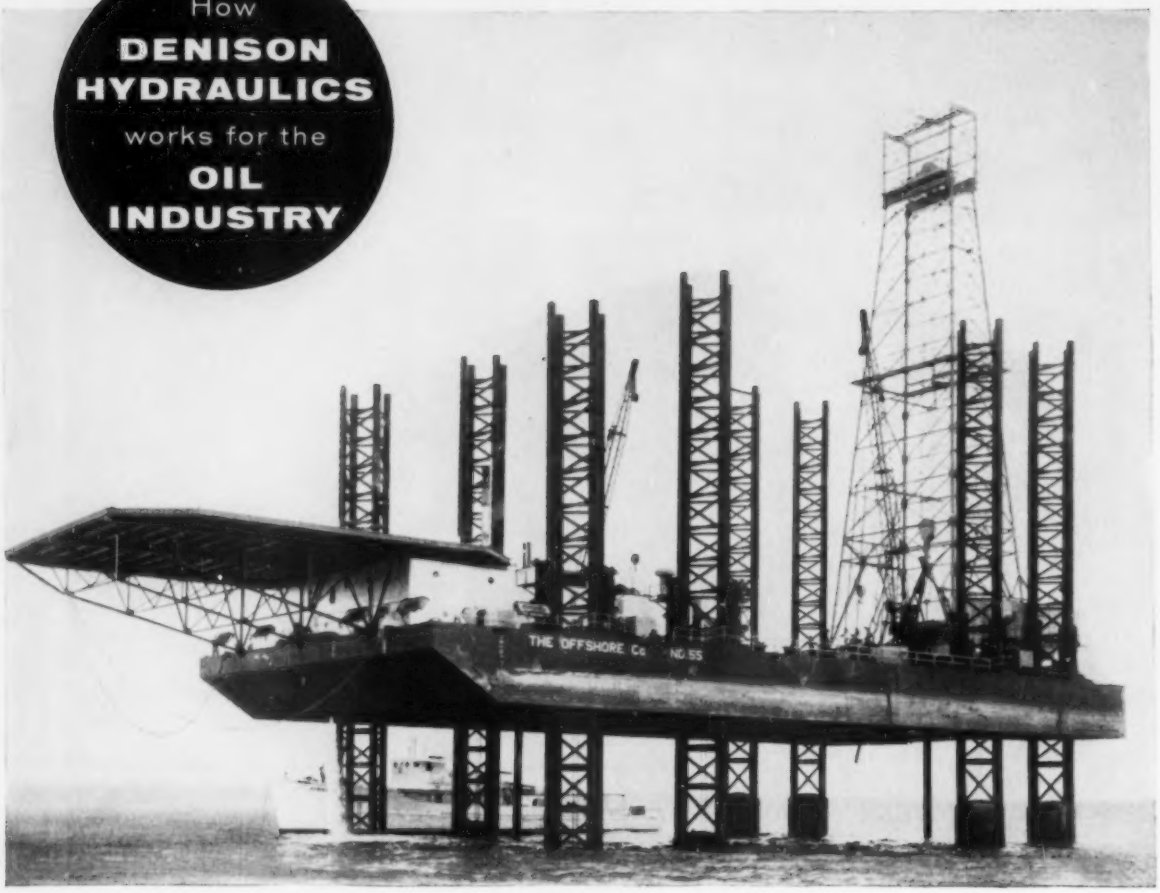
Lower Left—Problem: Design a trailer to haul more coal and stay within the legal highway weight limit. Solution: Marion Metal Products Company used USS COR-TEN High-Strength Low-Alloy Steel to build a bigger trailer that is lighter because the stronger steel can be used in thinner sections. Payoff: The new units weigh 23% less than the old, have a 50% greater payload, and gross weight is *still* within the legal limit.

Lower Middle—Problem: Build a 40-ton-capacity bottom dump trailer that would have the highest payload-to-weight ratio ever obtained. Solution: Athey Products Corporation designed the unit with USS "T-1" Constructional Alloy Steel which combines a minimum yield strength of 100,000 psi with weldability and remarkable toughness. Payoff: New trailer weighs 11,000 pounds less than conventional construction and hauls payload over 3½ times its own weight.

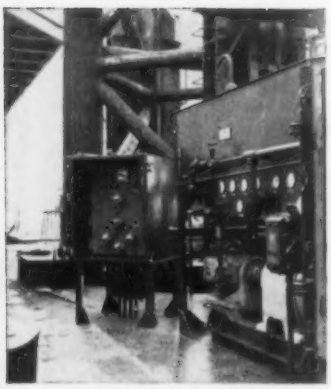
Lower Right—Problem: Replace 550-bbl. fermentation tanks with new tanks of same capacity but light enough to hang from the ceiling. Solution: Chicago Steel Tank chose Type 304 Stainless Steel and a unique new design utilizing Stainless Steel's strength and formability. Payoff: New tanks weigh only one-fourth as much as the old and have identical capacity.

USS, COR-TEN and "T-1" are registered trademarks

How
DENISON HYDRAULICS
works for the
OIL INDUSTRY



Lifts 6000 tons out of the sea with
DENISON HYDRAULIC PUMPS



Actuating System Controls *for raising and lowering heavy off-shore rigs built by DeLong Corporation, New York. Denison axial piston pumps actuate hydraulic jacking cylinders, separately or in unison.*

When The Offshore Company faces the problem of raising its 6000-ton DeLong drill barges, they rely on Denison axial piston pumps to deliver the necessary muscle. Rated at 5000 psi continuous duty, four Denison pumps lift the 6000-ton platform at rates up to 15 feet per hour . . . with precision control from one central source.

Utilizing a Series 800, 35 gpm Denison pump at each corner, the hydraulic system developed by DeLong and built to specifications by Denison is capable of actuating lifting jack cylinders separately or in concert as needed. The result is close regulation of the massive 6000-ton load through a system of 16 individual hydraulic jacks on 8 caissons or towers.

Whatever your actuating problem, Denison can help you develop an efficient hydraulic system to do the job dependably and at low cost. Why not consult Denison on your next job. No obligation. Write us. Denison Engineering Division, American Brake Shoe Co., 1194 Dublin Road, Columbus 16, Ohio.

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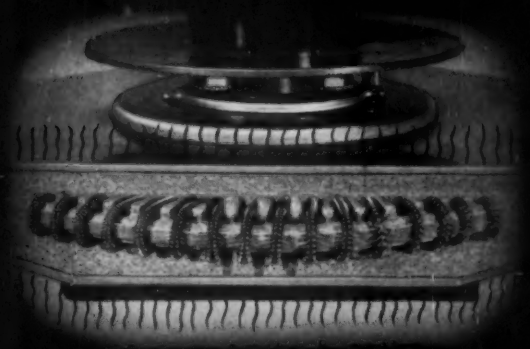
DENISON HydrOILics

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS



Heat dissipation front and back

Adjustable stops

Wear-resistant contacts

Stable operation, hour after hour

FOUR REASONS WHY

G-E rheostats give top performance at low cost

General Electric plate rheostats offer many outstanding features to give you the best possible performance with minimum cost and maintenance. These features include:

Greater heat dissipation—completely metal-encased and cement-filled rheostat dissipates heat from both sides. This allows a smaller, lower-cost rheostat to be used for a given rating.

Easily adjustable stops—two movable stops can be set to predetermine the range of operation of the G-E rheostat.

Less contact wear—the movable contact rides on special wear-resistant segments, not on the resistance wire. This substantially increases the operating life of the rheostat.

Stable operation—once the rheostat is set on the desired rating, it will maintain that setting with negligible change in resistance, resulting in dependable "set-and-forget" operation.

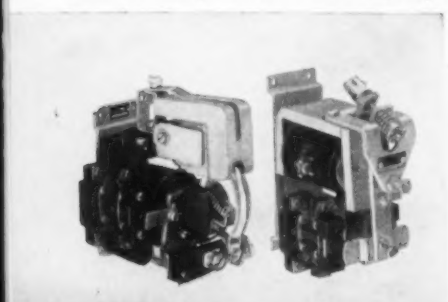
Act now! You can get G-E rheostats in six-, nine- or twelve-inch sizes, dissipating as high as 1100 watts per plate.

NEED OTHER COMPONENTS?

General Electric also has complete lines of contactors, relays and resistors for all your control needs. For more information, contact your G-E Sales Engineer or mail this coupon today! Industry Control Dept., Roanoke, Va.

GENERAL ELECTRIC

D-c contactors and relays—feature new "building-block" construction to give maximum flexibility with minimum inventory.



Vitreous-enameled resistors—1070 ohmic values from stock, fixed or slide wire, 5 to 200 watts. Call your G-E representative.

To: Section B784-14
General Electric Co.
Schenectady 5, N. Y.

Please send the following bulletins:

- ☐ GEA-6474—Plate-type rheostats
- ☐ GEA-6592—Vitreous-enameled resistors
- ☐ GEA-6621—D-c contactors and relays

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Company _____

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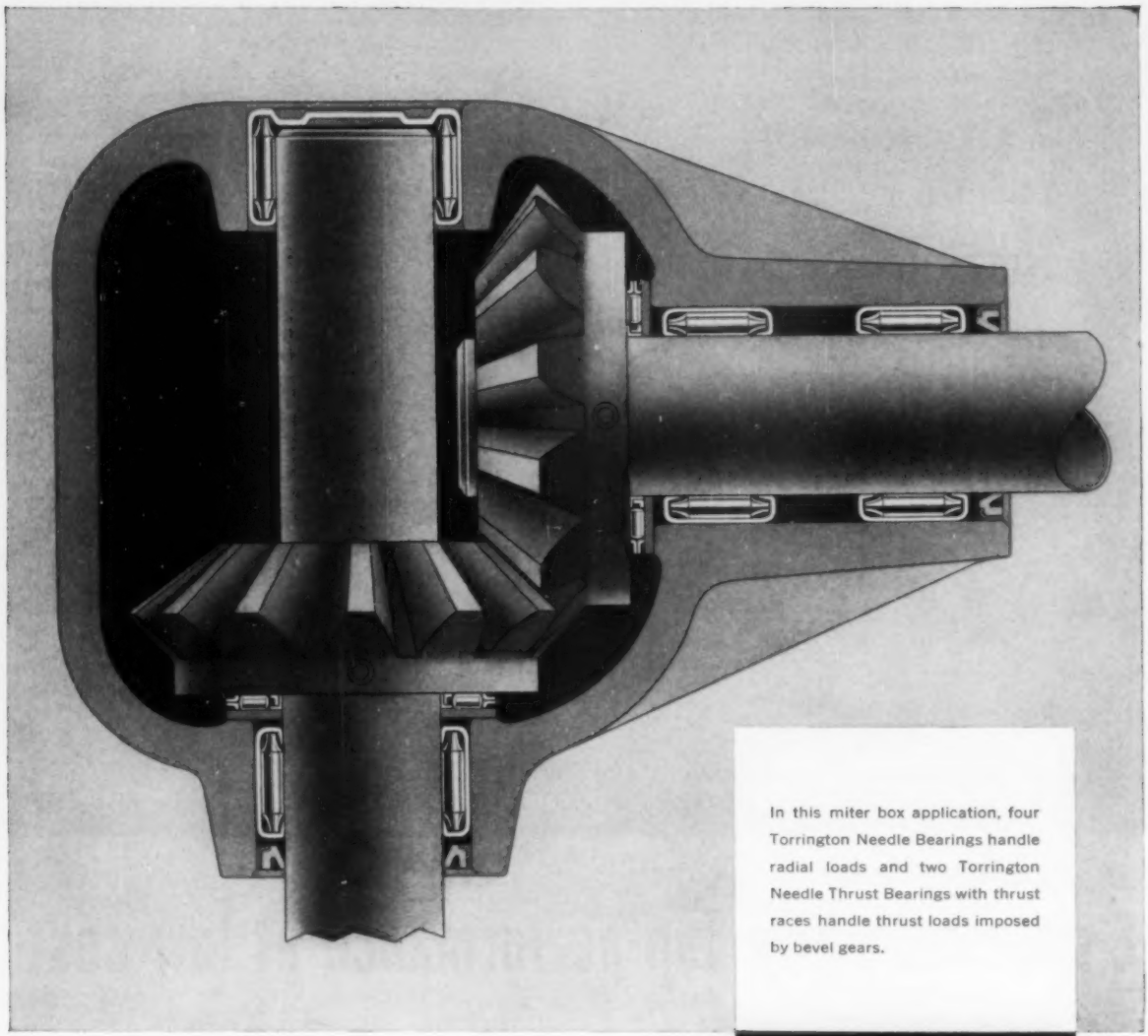
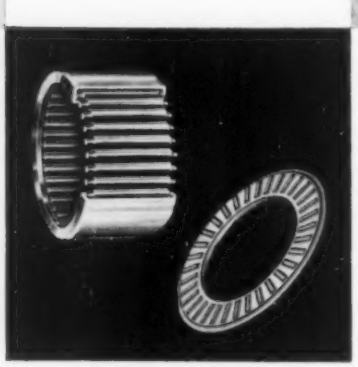
City _____ State _____



In this miter box application, four Torrington Needle Bearings handle radial loads and two Torrington Needle Thrust Bearings with thrust races handle thrust loads imposed by bevel gears.

Perfect Combination for Thrust and Radial Loads



Here's a space-saving, cost-saving way to handle high thrust and radial loads. Just team up Torrington Needle Bearings with Torrington Needle Thrust Bearings!

With their full complement of small diameter rollers, Needle Bearings handle higher radial loads than any other anti-friction bearing of comparable cross section. And Needle Thrust Bearings are only .0781″ thick – as thin as an ordinary thrust washer. Together they make a perfect combination of compact, light, rugged anti-friction bearings.

Either type of bearing may be run on hardened and ground adjacent parts to meet minimum space requirements. Or they may be used with standard races available from Torrington. To make the most of this efficient combination, call on our engineering staff for application advice. **The Torrington Company, Torrington, Conn.–and South Bend 21, Ind.**

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • BALL • NEEDLE ROLLERS • THRUST

DEVELOPMENTS TO WATCH...

Dashboard lighting by a new route . . .

. . . will be featured in one of next year's (1960 model) Big Three autos.

The route: electroluminescence, which provides a glowing, area source of light by activation of a phosphor coating with an alternating electric field.

Costs of such glow panels are now down to a point where the application is practical, suppliers claim. A 4 by 6-in. metal-based electroluminescent speedometer dial, for instance, should not cost more than $3.50, and might well be less than a dollar when produced in quantity.

Panels of this type are expected to have a service life of 30,000 hours or more; and their current drain should be less than 0.1 milliamp/sq in. (For a full-scale report on today's uses for this type of lighting, see Sept. 15 issue.)

A motor that will run full of water . . .

. . . or even completely submerged in water, has been designed by General Electric Medium AC Motor and Generator Dept. engineers. This is not an enclosed "submersible" unit, but an integral-horsepower motor designed from the winding out with water-resistant, corrosion-resistant materials and components so that water can circulate right through the electrical as well as mechanical parts. Especially important, says GE, is the insulation that was used. Look for additional details in Sept. 1 issue.

New, simpler pneumatic systems . . .

. . . are being developed for everything from machine tools to airplanes. One example is the clamp described below.

Another comes from B F Goodrich Aviation Products. It's introducing a pneumatic de-icing system that "eliminates the pumps and oil filtering and separating equipment, timers, solenoid valves and miscellaneous plumbing" associated with conventional de-icing methods. Furthermore, says Goodrich, about half the weight (22 of the total 50 lb) is in the form of major components which can be removed when the system is not in use.

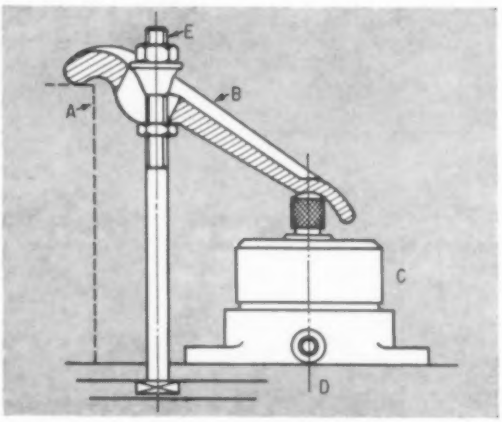
The activating gas, at a working pressure of 3000 psi, is stored in a glass fiber sphere, similar to that used on the first stage of the Explorer satellite, where the pneumatic system is a key component of the launching mechanism. This particular unit was designed for light planes.

Pneumatic clamp for machine tools . . .

. . . developed by Blasi, A G; Solothurn, Switzerland, is said to be unusually simple and foolproof. It consists of a compressed-air cylinder (C), the piston of which applies a force to a clamp (B), held in position by a T-bolt (E).

According to the company, only three sizes of T-bolts are required to accommodate workpieces (A) ranging in size from 0 to about 7 in. Furthermore, several clamps may be connected to the compressed air line through a single control valve so that they will operate simultaneously and pressure will be evenly applied.

The system can be made to operate automatically; and, with the normal pressure of 6 atmospheres, four cylinders having piston diameters of about 2.8 in. can exert a total clamping force of about 6000 lb.



DEVELOPMENTS TO WATCH...

Papers with high dimensional stability . . .

. . . for use in printed circuit boards, transformer board, filters, tabulating machine cards and other industrial applications are being produced experimentally by Owens-Corning Fiberglas Corp in cooperation with several paper companies.

These papers, which combine relatively small amounts of glass fiber (2 to 10%) with cellulose fibers, are said to offer a good many advantages besides: tear strength is higher, density and porosity can be controlled, and processing characteristics are considerably improved.

In making the new papers, the glass fibers, in sizes from ½ to 9 microns, are added to the wood fiber during the papermaking process, and become an integral part of the paper. When the larger (9-micron) fibers are used, the estimated increase in raw material cost per ton of paper produced is no more than $30 to $35.

In papers so far produced, little effect on tensile or burst strength has been noticed, but there has been some reduction in fold endurance. O-C is working on improving the adhesion of the glass to the cellulose fibers, and believes that this will not only increase strength but also fold endurance.

Information on the new papers may be obtained from Industrial Textile Div., Owens-Corning Fiberglas Corp., 598 Madison Ave., New York 22, NY.

(For a roundup of other new materials, made of silica and ceramic as well as glass fibers, see *PE—July 7, p. 70*; and for information on other types of paper, from cellulose, metal, and fungus fibers, see *PE—Jan. 6, p. 34; Feb. 24, p. 12; and Mar. 3, p. 17.*)

Another new printing system . . .

. . . using photosensitized plastic plates has just been announced. Like the process being developed in the US by DuPont (*PE—Aug. 4, p. 20*), this new German system is designed to make relief printing plates from original negatives by taking advantage of the fact that light will harden pre-sensitized resins, leaving the remainder of the plate soft so it can be dissolved away.

In the German *Helio-Print* system, the photosensitive material is wiped on to the plate instead of being incorporated in it as in the DuPont process. Then, the negative is placed over the plate, and the two are exposed to the light. A developing compound removes the unexposed areas, and the plate is ready for use.

To go with the plates, the German company, Rote-Werke AG, Koenigslutter, has developed an office-type duplicating machine which, it says, will produce up to 100 prints an hour. However, the plates can also be used on a regular press. Cost of the plates, in standard letter size, is about 36¢, and, the company says, they can be used for over a million impressions. The office printing machine is priced at about $1,110, makes 100 prints in an hour.

No more front windows . . .

. . . for TV sets, says Pittsburgh Plate Glass Co. Now "in the final stages of development" is a new laminated "safety tube" that "makes possible the elimination of the separate front window, now standard on all TV sets," and "provides a picture brightness improvement of from 8 to 9%, improves contrast . . . and eliminates objectionable reflections" to boot. PPG also expects it to permit reductions up to 4 in. in cabinet depth and reduce supporting structures.

The tube doesn't really dispense with the safety window—just moves it, right on to the tube itself. A lightweight layer of safety glass, etched to provide a glare-reducing surface, is laminated to the face of the tube by a layer of polyester resin.

The laminating technique itself is new, might well prove useful in other products.

Abrasion protection for glass . . .

. . . is provided by a new silicone surface treatment which is also claimed to be highly effective in preventing dust accumulation. Developed by Donnelly-Kelley Glass Co, Holland, Mich., it is expected to prove useful in mirrors for vending machines and other mechanical products—almost any place where repeated cleaning of glass parts is involved. Donnelly-Kelley thinks the process may also have application in instrument mirrors, critical glass parts for guided missiles, and the like. —ARG

THE ENGINEERING WEEK

House Passed Tax Bill Aids Consultants

WASHINGTON—The House has just passed the Jenkins-Keogh bill (H.R. 10) which permits self-employed business and professional men to deduct 10% of their annual self-employment income, up to an annual maximum of $2,500 to be set-aside in a restricted retirement fund. The lifetime maximum which can be deducted for this purpose is $50,000.

Provision is made to withdraw the money at retirement age (65), at which time taxes are paid on the sums as they are withdrawn, but usually under circumstances where the overall tax rate is less. The money may be withdrawn before the individual reaches 65, but a tax penalty is imposed if this is done. The bill is posed if this is done.

The bill still must be passed by the Senate, and traditionally such money bills get shunted aside in the hurried closing days of Congress.

Higher Court Grants Inventor "Closed" Trial

NEW YORK—The Second US Court of Appeals here has just reversed the decision of the US District Court which denied Dr. Otto Halpern a closed court session to sue the Government for compensation for use of his invention (*PE, June* 1957, *p.* 199 *and July* 7, '58, *p.* 49). The US Government has 60 days to file an appeal to the Supreme Court if it decides to do so.

Dr. Halpern's invention was regarded important to the national security to the extent that the Navy would only describe it as: "A manner and means whereby an object may escape observation by radar." Dr. Halpern, through his attorneys, Ward, Neal, Hazeltine, Orme & McElhanon, brought suit against the government last year for adequate compensation for the use of this invention by the military services. The US District Court in New York dismissed the suit on a claim by the Navy, which said that, "all testimony related to the subject are military secrets, the release of which would prejudice the country's security."

Foreign Countries Move Slowly toward More R & D Spending

McGraw-Hill World News spotcheck of England, France, West Germany, Japan, Sweden reveals decided lag behind US. Most R & D money in these countries goes for defense; private industries are spending more but reluctant to tell how much.

TOKYO—In Japan, a large part of the R & D for industry is carried out in 11 government labs run by the Institute of Industrial Technology. These labs span the fields of machinery, electronics, aeronautics, chemistry, metallurgy and textile manufacturing. Government participation in industrial research is extensive because Japanese companies, small and poorly capitalized, cannot afford to do it themselves.

Research done by the Institute is passed on at no charge to the first company that requests it. The company is free to commercialize the results. Nippon Electric, early this year, got manufacturing rights for the Mark IV computer developed by the Electronic Technology Laboratory.

The Institute's budget has gone up from $13 million in 1950 to $27 million in 1957. Half the appropriation supports work in the 11 labs, the other half subsidizes R & D in private industries. Candidate industries for government subsidy are awarded grants for projects of special interest to the government. Recently, the Institute awarded 116 contracts—about 33% of the total—for machinery development.

Some of the larger firms here are supporting R & D on their own—in cases about matching the government subsidy. Mitsubishi Heavy Industries, a heavy-machinery and aircraft manufacturer, reports its total R & D up from an annual rate of $4.3 million in the 1954-57 period to $8.1 this year. Broken down, this year's figures are $1.8 million on basic and general research, $4.2 million on jet fighters, $2.1 million on helicopters and transport planes.

More typical of the Japanese scene is a small industry, Natori Works, Ltd., (capitalization $14,000) one of the three major printing-press builders. This company makes a press weighing over 500 tons. Natori has no R & D, but will experiment with design improvements on the orders from customers. Customers apparently do not object to being guinea pigs.

LONDON—The British say they are spending $900 million on R & D annually. This estimate originates with the Department of Scientific & Industrial Research—it admits the figure may err by 25% either way. Defense R & D accounts for about 60% of the total.

Broken down, spending looks like this: out of the total, private industry spent 57%, primarily on the following: aircraft, $252 million; electrical engineering, $90 million; chemicals, $56 million.

Since these figures were compiled, industry R & D has increased though defense expenditures have probably stabilized. Still, no one is happy about the magnitude of R & D. Britain is thought to be lagging behind the US even though most big private companies and the state corporations have R & D departments. Also a number of specialized research associations are active.

Topheavy R & D for defense is said to abnormally emphasize nuclear energy and aircraft along with electrical, electronics and certain materials industries.

Most companies shy at revealing R & D spending, feeling such figures might be misleading if quoted out of context. A few companies, like Imperial Chemicals Industries and General Electric, do make figures public. For its last complete budget year, ICI spent $37.8 million on R & D—60% for research and 40% for development. In 1956 ICI spent $33.6 million and in 1953, $21 million. Re-

portedly, ICI averages 2.8% of gross annual turnover on R & D.

GE pumps about $10.6 million into research annually (they will not reveal development expenditures), spending 85% for industrial and applied electronics research, and 15% for atomic energy research. Profits run about $27 million a year.

BONN—German companies zealously guard statistics bearing on R & D and often themselves do not know what they spend. Once out of central research, the cost of projects becomes diluted in plant budgets.

The only comprehensive effort here to pin down R & D was made by Deutscher Stifterverband, a department of the Federation of German Industry. Its survey indicates industry spent $190 million in 1956 and $200 million in 1957. The department has guessed R & D ran $128 million in 1955 and $70 million in 1952. If these figures are correct, research has increased from 0.25% of total sales in 1952 ($28.4 billion) to 0.47% of sales ($44.2 billion) in 1956. In large industries probably 1% to 5% of are plowed back into research.

Though no firm figures are available, heaviest expenditures are reported in chemical, optical and electronics industries (the latter two stressing measurement and control) where research may account for 5 to 6% of sales (in optics, 5 to 15% of total employment is in R & D).

Machine-tool builders concentrating on electronic controls farm their research out to public institutions. In the automotive and aircraft industries, research is small. The emphasis among many auto companies is on production, styling and materials-handling projects that do not qualify as research in German terminology. Barred from producing aircraft until three years ago, the aircraft companies have many R & D problems but limited funds. Aviation research institutes are doing about $3.5-million research this year.

German payments for foreign license and patent rights are rising faster than receipts from licensing German products abroad. Payments for German patents rose from $950 thousand in 1952 to $4.3 million in 1957 (350%), while payments by Germans rose from $3.8 million in 1952 to $25 million in 1957 (650%). Some observers cite these figures as evidence that German industrial research is getting insufficient support from big companies. However, interest in research is growing among small and middle-sized industry.

Industry, on the other hand, asserts that research is being intensified and German firms are abreast of scientific developments even in fields such as nucleonics, radar and electronics where activity was prohibited until a few years ago.

PARIS—Government and most industrialists here agree that R & D is increasing—but not fast enough.

Economists have pegged average R & D budgets at around 5% of sales. But no one knows except manufacturers, who are not talking. Said one, "We do not make propaganda with our research spending as some American companies do."

Renault, a top auto manufacturer, reports a staff of 1000 engineers and technicians on R & D projects. Most of these however, are on assignments to cut production costs for the four CV's and Dauphines now rolling off the assembly lines. A few Renault engineers are also working on propulsion turbines and advanced auto models.

Trade association sources confirm beliefs that R & D is rising. One association estimates that spending by the mechanical industries runs between 1 and 6% of budgets. An association survey of electronics manufacturers put R & D at 7½% of budgets in 1952. The association says more is spent today.

In aircraft, R & D spending is off, as the French government has cut budgets. Sud-Aviation, the largest manufacturer, recently closed a research facility for lack of funds.

STOCKHOLM—Figures on Swedish R & D are not available. Where they exist, industries will not release them. A variety of reasons lie behind R & D secrecy—in aircraft, for example, R & D is almost exclusively military. The Research Institute of Swedish Industries will make a survey later, but has no figures at present.

In Sweden, industry has access to the work done by a number of scientific research institutes supported by the government. Appearance research is generally handled through freelance designers.

Hence, R & D in Swedish industry appears to be low compared with the US. The Volvo PV 444, put on the market shortly after World War II, now has a more powerful engine but has undergone only minor design changes otherwise. It looks the same.

First mobile digital computer . . .
has been designed by Sylvania Electric Products, Inc., for the Army Signal Corps. Though tailored to military needs, MOBIDIC could have application in private industry —as a quick-delivery rental service for companies that can't afford to buy or long-term-lease a computer. Designed to fit into a standard, 26-ft trailer, all-transistorized MOBIDIC requires no cooling system, will function efficiently in extreme climates, under difficult terrain and combat conditions, and is intended to solve military problems ranging from battlefield strategy to logistics.

Typewriter for engineers . . .
This double-keyboard typewriter has a total of 180 characters. The keyboard at left is essentially the standard typewriter keyboard, but with several mathematical symbols replacing the usual signs found on the top row of keys and to the side. The keyboard at right has all capital and lowercase Greek letters, small numbers for sub- and superscripts, squareroots, integrals, lower case italicized letters, is greater than or equals, summation sign, approaches as a limit and others. The typewriter was designed for Britain's Atomic Energy Research Establishment by Imperial Typewriter Company, Ltd., Leicester, England.

British Drop Liquid-cooled Reactor Systems

LONDON—Further development of liquid-cooled reactor systems has ceased here and work on the fast reactor projects and several other systems curtailed. Gas-cooled systems are now getting full priority.

In dropping the liquid-cooled systems after extensive design studies during the last three years, the Atomic Energy Authority (AEA) maintains that the sodium system has too many serious technical problems, and the pressurized water reactor is uneconomical in Europe because it needs highly enriched fuel.

The high-temperature gas-cooled reactor system will depart entirely from metal-like fuel components and will work on the uranium-thorium breeding cycle. Gas temperatures will reach 1300 F commercially by 1970. This is comparable with the latest steam conditions and, according to AEA, will prove useful for gas turbine applications, propulsion equipment and power-station needs.

In the US, the AEC has just finished a lengthy study on the gas-cooled reactor concept to determine whether this country should support a development program in this area. The result: AEC believes the US has enough technical knowhow to start building gas-cooled reactors as advanced as any now being built. Congress gave AEC $51-million to do the job. Those in on the development program were Kaiser Engineering, ACF Industries, ORNL and Hanford.

Fusion Power: How Cheap, How Soon?

WASHINGTON—The AEC's latest semiannual report takes, at first glance, an optimistic view of the development of thermonuclear power. But a closer look tells a different story.

In listing "Benefits of fusion power," AEC says: "The fuel costs would be extremely low . . . if the nuclear-energy content of a pound of deuterium (heavy hydrogen) could be converted completely into electrical energy . . . it could yield 40 million kw-hr of electricity . . . and the gross fuel cost would be only 0.0035 mils per kw-hr."

Actually, though, the best fission reactors convert only a fraction of the energy available in their uranium fuel into useful power (*PE*—Apr. 14, p 52); and, the AEC admits, the cost figure does not consider the operating efficiencies of the powerplant or the capital costs of the reactor, which may be "considerable."

These calculations are based on the assumption that useful fusion power can be achived—an assumption not yet fully justified. Says the AEC, "There is no real proof that a thermonuclear reactor yielding net power can be built; however, there is no proof that it is impossible either."

It is quite likely that fusion reactions will be created in the laboratory within the next few years. The AEC has few doubts that the 100-million-degree temperatures required can be achieved. But reaching the next goal —creating a machine that will produce more power than it consumes in reaching that temperature—"is probably many years away."

Commercial plants are obviously on the far horizon. As the report itself notes, fission reactors have been producing power for about seven years, but "production of electricity (even by this type of plant) at costs competitive with those of conventional power plants has yet to be demonstrated."

Bits And Pieces

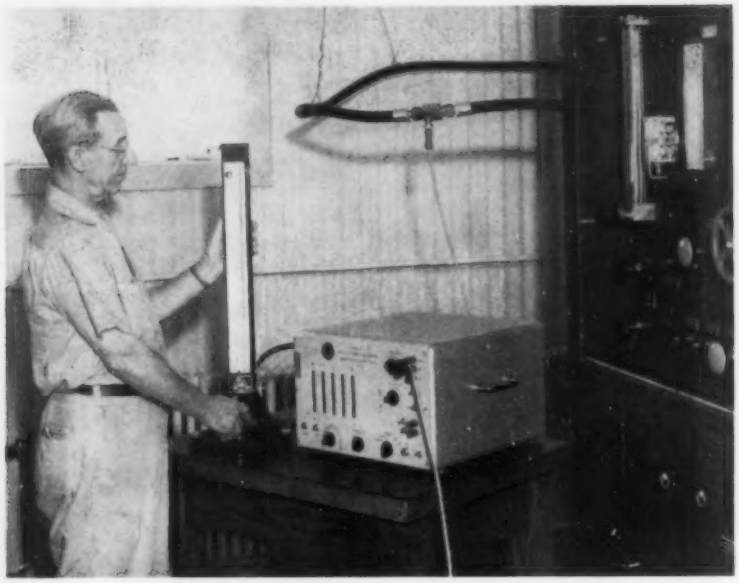
BEFORE HE LOOKS FOR A JOB . . . a young engineer singles out a few companies as potential employers on the basis of their growth potentials, stability, past technical achievements and personnel policy as it affects the professional man, according to a motivation research study by Deutsch and Shea, Inc., technical manpower consultants. Engineers' opinions are based on their contacts with professional men, use of company products, company articles and advertising, convention displays and other sources . . .

BRITAIN'S FIRST LETTER SORTER . . . capable of handling 6,000 letters an hour, dropping then into 144 compartments, will have to have its operation cut back to 3,000 letters per hour—maximum coding speed of the machine's operator. The British PO has ordered 20 machines at $42,000 per . . .

THE TVA . . . may perform engineering services for outside parties in connection with the construction of a generating plant or other facilities in which the TVA has any connection, according to a pending bill (S.1869) passed by the Senate and now before the House Committee on Public Works. The National Society of Professional Engineers, which objects to the proposal, testified before the Committee stating that the bill "constitutes an unwarranted interference with the normal functions and operations of private consulting engineers."

800 TONS OF STEEL PER HEAT . . . will be the capacity of Russia's new automatic open-hearth furnace, reportedly the largest in the world. The Russian report says that the furnace will use new methods of fuel burning, slag disposal and rapid charging.

EUROPE'S NUCLEAR-POWERED SHIP . . . its first, is still in the planning stage in Goeteborg, Sweden. The proposed 65,000 ton tanker will have a 30,000 hp rating. Several standby 3,000-hp diesel units, plus a main 5,000-hp diesel prime mover will keep the ship moving at an emergency speed of 9 knots. Estimated speed under nuclear power will be 18 knots.



Direct-reading viscometer . . .
shows viscosity of test liquid during calibration of a turbine-type flowmeter (top center). Digital frequency-time counter on table measures output of flowmeter, while calibrating stand (right) accurately determines flow rate.

NBS Develops Direct-reading Viscometer

WASHINGTON—A direct-reading viscometer that measures liquid viscosity by loss of head across two restrictions instead of measuring the time required for liquid to pass through a capillary, has been developed at the National Bureau of Standards. With the new device, viscosity can be measured continuously from a manometric column without calculations or corrections—impossible with a capillary which requires a gradual or analytical conversion to viscosity. The device needs no electronic components or power connections.

Developed to fit the needs of aircraft engines for fuel-flow meters and fuel-metering components, the viscometer consists of two flow restrictions—a capillary and an orifice—of different configuration and in series. Manometers measure total head loss across both restrictions and across the downstream restriction alone. When total loss is held constant while passing different liquids, then head loss on the downstream restriction is a direct function of kinematic viscosity. The viscosity can be read directly from a scale next to the second manometer.

Now in prototype, the viscometer measures between 0.5 and 5.0 centistrokes to an accuracy of 2% and can be used for aviation fuels—gasoline, naptha, kerosene, and jet fuels. For other applications, instrument range may be varied by altering the size and configurations of the fixed restriction.

USSR Technical Journal Abstracts Available

WASHINGTON—The Government has published its list of 141 abstracted Russian technical journals that can now be bought from the Dept of Commerce's Office of Technical Services. Companies can subscribe to the journals on an annual basis.

Here are a sample of journal abstracts offered with the annual subscription price and order numbers:

PB. 141111T Power Machinery Construction, Monthly, $6

PB 141112T Measurement Techniques, Bi-monthly, $3

PB 141119T Instrument Manufacture, Monthly, $6

PB 141121T Machine Tools and Tools, Monthly, $6

PB 141125T Automatic Welding, Monthly, $6

PB 141131T Metallography and Metal Working, Monthly, $6 a year.

A complete list of Russian material is available through the new Office of Foreign Technical Information Center, Office of Technical Services, Department of Commerce, Washington 25, D. C.

At present, only abstracts of the journals are available through the OTS. Copies of the original Russian language documents are available from the Library of Congress, however. Companies can by the documents and have them translated on their own if a complete translation of an article is desired.

In some cases, the OTS abstracted Russian journals are also translated in full by National Science Foundation supported programs. A complete list of the 31 Russian technical journals that are translated under the auspices of the NSF can be obtained from the Office of Information, National Science Foundation, Washington 25, D. C.

COMING EVENTS

AUGUST

18-21 . . . . American Society of Mechanical Engineers, American Institute of Chemical Engineers, Joint Heat Transfer Conference, Northwestern, Evanston, Ill.

19-22 . . . . American Institute of Electrical Engineers, Pacific General Meeting, Hotel Senator, Sacramento, Calif.

19-22 . . . . Western Electronic Show and Convention, Pan Pacific Auditorium, Los Angeles.

SEPTEMBER

1-7 . . . . International Association for Analog Computations, Second International Conference for Analog Computations, Strasburg, France.

4-5 . . . . American Society of Mechanical Engineers, International Conference on Air Pollution, Hotel Statler, New York.

8-11 . . . . Society of Automotive Engineers, National Farm Construction and Industrial Machinery Meeting, Production Forum and Display, Milwaukee Auditorium, Milwaukee, Wisc.

12-13 . . . . Society of Plastics Engineers, Plastics for the Automotive Industry, St. Clair River Inn & Country Club, St. Clair, Mich.

15-17 . . . . American Institute of Electrical Engineers, International Conference on Computer Applications in the Power Industry including design of rotating and non-rotating machinery, King Edward Sheraton Hotel, Toronto, Canada.

Swollen Rubber . . .
right, after immersion in oil has increased from about 6 in. to 8 in. square. New GE nitrile silicone rubber, left, is unaffected after same exposure to oil.

Rubber Resists Oil at High, Low Temperatures

NEW YORK—"Some extra frosting on the cake for design engineers" is the way Dr. Guy Suits, vice-pres and director of Research for General Electric Co put it when he announced the company's new nitrile silicone rubber. In one material the new rubber combines the good resistance to oils and fuels of nitrile rubber with the excellent performance over a wide temperature range (−100 F to 500 F) of silicone rubber.

Some immediate potential applications are: aircraft (o-rings, seals, gaskets, hoses, couplings, other high-low temperature uses); automotive (automatic transmission seals, crankshaft seals, rubber brake parts, power steering pump parts, pinion seals, air suspension system).

Price of the new rubber, which is expected to be commercially available by next January, will be approximately $15 per pound, already compounded and ready to mold or fabricate. This price compares favorably with the $15 per lb raw gum figure for Du Pont's recently announced fluorocarbon elastomer, Viton A, and Dow Corning's fluorinated silicone rubber selling at $25-30 per lb. GE claims to have a lighter material (a lower price per cu in.) as well as being the only one to meet a current Air Force target for an elastomer with good oil resistance from −65 to 350 F.

GE says that the nitrile silicone rubber will be and expects a premium material for several years. The new rubber is a joint development of GE's Research Lab in Schenectady and the Silicone Products Div. at Waterford, N. Y. New facilities are being built to produce the nitrile silicone rubber, however, GE says that present silicone-fabricating equipment will handle the new rubber.

Vast Shipbuilding Program Poses Design Problems

WASHINGTON—During the next 10 to 15 years, US ship owners are slated to spend over $3-billion for building new ships. This vast program—¼ of it is already underway—offering design engineers a weighty challenge to find ways to carry cargo.

Aero-jet General Corp. has a $36,000 contract to study the value of building big nuclear powered, cargo-hauling submarines that would travel about 100 ft below the surface of the ocean. Size of the proposed submarines would be around 500 ft long with a 47-ft beam. Its speed would be about 35 knots. Attached to the cargo submarines, but rising several feet above the ocean surface, would be a delta wing structure to house the crew and controls.

General Dynamics Corp. has a $34,000 contract to look into the practicability of building big nuclear submarine tankers. These would operate completely below the surface of the ocean with special living space and control compartments built that would automatically rise to the surface if major damages occurred in the vessel. Speeds of around 50 knots are envisioned for these craft.

Grumman Aircraft Engineering Corp. of Bethpage, New York, has a $75,000 contract to study the advantages of building passenger ships equipped with hydrofoils. Ships with around 300-passenger capacity can be built on this principle and attain speeds up to 100 mph. Smaller passenger craft already are using hydrofoils successfully in Italy and Venezuela. The Navy has been experimenting with them for landing craft use.

Basic reason for turning to submarine vessels is to escape the hinderance of the ocean's surface to ship operations. When ocean storms whip up high sea, surface vessels are forced to reduce speed, often divert their course. These weather factors alone cost the shipping industry hundreds of thousands of dollars each year.

The advances in submarine design made by the Navy has proved that vessels can be propelled faster underwater than on the surface. Other factors, such lower initial construction costs and smaller operating crews make the proposition highly attractive.

Boldest thinking—and it's still in the thinking stage—in the way of new designs for ships is the concept of floating ships a few feet above water with the use of compressed air. Both the Maritime Administration and the Navy are interested.

Basically, the concept envisions jets of compressed air shooting out from underneath the vessel. These would lift it just high enough above the surface of the water to clear waves. Once clear of the water, the vessel could easily achieve high speed rates.

Costs, once the first experimental ships are built, would likely be no more, and possibly less, than what a conventional ship now costs—up to $100 million for big passenger ships, and $10-million for cargo vessels.

Ship owners are also looking for new types of cargo-handling devices to replace the old winch-and-boom system of loading ships. Under consideration are overhead cranes on rail tracks that quickly lift cargo from docks and position it in the ship's holds. Mechanically operated hatch covers are a likely bet for the new ships.

Court to Engineer: "Keep Ex-employer's Secrets"

SALT LAKE CITY—The question of how much of an engineer's knowledge gained on a job belongs to his employer has been determined for Charles M. Miller in US District Court here.

Judge A. Sherman Christenson on July 28 permanently enjoined Miller, an employe of Central Farmers Fertilizer Co, Chicago, from utilizing certain Monsanto Chemical Co trade secrets in construction of an elemental-phosphorous furnace at Georgetown

Canyon, Idaho. Central Farmers, made up of 14 large Midwest cooperatives, is building the furnace as part of a dicalcium metaphosphate plant.

Miller, formerly employed by Monsanto as an engineer at its Soda Springs, Idaho elemental-phosphorous plant, also was ordered by Judge Christenson's decision to return some 102 documents he "appropriated".

Monsanto had filed suit in this court late in 1956, naming as defendants: Miller, Central Farmers, and F. C. Torkelson Co, Salt Lake City, which had design contract for the plant. Central Farmers was not served in this case, nor was an injunction issued against Torkelson, but the judge held the firm may be enjoined if it utilizes any of Miller's information obtained from Monsanto. Miller was further enjoined from consulting with Torkelson in such manner as to reveal any Monsanto secrets "which were acquired by Miller in the confidential relationship of employer-employe."

Monsanto accused Miller of divulging confidential information in violation of a contract he signed when working as an engineer for the chemicals company. The defense contended no "secrets" were involved, and that Miller had been employed elsewhere between the time he left Monsanto and was hired by Central Farmers.

Only part of Judge Christenson's findings were made public. However, he determined that: (1) Miller's contract regarding knowledge gained and secrets learned while on Monsanto projects was a legal instrument, and (2) in any event, common law would prohibit disclosure of trade secrets of any employer, even though the employe had severed connections with the employer.

Counsel for Miller said he already has returned the documents, and is no longer working on Central Farmers' elemental-phosphorous unit. The Torkelson firm also has been removed from design engineering work on the furnace to another part of the plant, and has been replaced by H K Ferguson Co, San Francisco.

Still sealed and not made public is a voluminous "Exhibit A" constituting the Monsanto trade secrets. The judgment stated that Miller "wrongfully" and "unlawfully" disclosed these trade secrets.

The finding of the court did not assess damages against Miller—this would require a separate suit.

READER TO EDITOR

First, Get the Facts

To the Editor:

Going through the article, An Engineer's Profile (June 16, p. 33) once over-all comment on the author's viewpoint is possibly that of mistaking the stereotype for the actuality—that a genius is usually bulbous-headed, with a spindly physique. Actual records that have been kept of gifted children for a number of years now show that the opposite is actually the truth. However, people with the stereotype in mind still can find examples of puny bodies housing good minds. In an occupation which does deal rather heavily in concrete facts and figures, a lack of ability for verbal expression can be ignored, or give the person who lacks such an ability a better chance of success than he would otherwise have in a highly verbal field such as law or politics. However, people who lack the ability to express themselves well usually find it very difficult to rise in the ranks and become successful in areas where management talent is necessary.

The author from Gaynor and Ducas, Inc., has fallen into a rather common trap of reasoning into the general from the specific. Such reasoning is often used in scientific and engineering work to deduce a theory. Theories have shown themselves to be valid only when proven so by the facts. As an example, phlogiston as a theory of combustion enjoyed a long life but was completely wrong. It would be interesting to see just what the basis is for the observations in the article.

—Leonard Greer
Asst. Chief Engineer, Penn-Union Electric Corp., Erie, Penna.

Feeding Bottle for Baby

To the Editor:

In the June 30 issue (p. 34) there is a plea from J. B. Helm for a plastic feeding bottle for infants.

Long ago, with out first child we decided that spoon feeding an infant was pretty rough so we just snipped a hole in the nipple and let baby feed himself—cereal, vegetables, anything that can be made up into a "goo." We have used such a method on eight babies. Beauty of the method is that no special equipment is needed; buy regular bottles, glass or plastic and simply snip a small hole in the nipple. What could be simpler? We have eight giants to attest to its practicality.

—J. H. Faupel
Research Associate, E. I. duPont Co.

Ball-type Worm Gear

To the Editor:

In your June 30 issue (p. 34) Mr. C. W. McLaughlin requested a ball-type worm-gear drive. I would appreciate your informing him that US Patent No. 2,836,985 issued on June 3, 1958, was granted to me, answering his problem.—Arthur M. Maroth
Maroth Engineering Co.
Wilton, Conn.

To the Editor:

Our Company is engaged in the manufacturing of ball-type worm drives in addition to our other ball bearing devices.—Floyd E. Miller
Beaver Precision Products, Inc.
Clawson, Mich.

Omitted Symbol

To the Editor:

A symbol was omitted from Fig. 2 of the article "Compression Strength of Thin-Walled Cylinders" (July 7, p. 77). The formula for allowable stress should have read:

$$F_c = E\left(K_c + \Delta K_c \frac{t}{r}\right).$$

Also, a short cylinder is less than $3.4 \times \sqrt{r\,t}$. No mention was made of the square root.

—Irene C. Kusmiss
Clifton, N. J.

Measuring Linear Speeds

To the Editor:

I noticed that in your column "Why Don't They Research and Develop" (June 2, p. 42) Mr. G. R. Searing put forth a need for a method for measuring linear speeds of various machine tools. We currently manufacture and sell a device suitable for this purpose. This unit has been in use for about 2½ years by a number of manufacturers, also, to original equipment manufacturers to include as a component part of their production.

—John D. Worrell
Maico Electronics, Inc.
Minneapolis, Minn.

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Good news for furniture buyers! But it may contain the germ of a profitable idea for you, too.

Urethanes have almost limitless application not only as comfort cushioning but as padding for impact absorption and vibration isolation, as thermal and acoustical insulation and in filling cavities for structural rigidity.

They can be flexible or rigid, made in a wide range of densities and resilience with exceptional mechanical and dielectric properties. Versatility in fabrication permits profitable innovations in design and production.

If you would like to learn more about urethanes, write on your company letterhead briefly outlining your interest. As makers of NACCONATE Diisocyanates, essential urethane components, we will gladly work with manufacturers to develop new applications.

Photo courtesy Heritage Furniture, Inc., High Point, N. C.

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CIRCLE 111 READER SERVICE CARD

New program timer features complete adjustability

In many applications, a timer has a "standard" job to do throughout its expected life, never requiring a change of timing sequence. But in many others, it's desirable to be able to change the timing sequence and the intervals making up the sequence in a complete cycle.

The new Cramer Type 511 and Type 521 Cycling Timers fill the bill for a unit combining high accuracy with complete field adjustability of as many as eight individual timed intervals. Although these timers can be supplied with preset cams to fit the needs of a present application, the added feature of adjustability makes them the ideal choice where the timing sequence may later be changed.

Operation

Applying power through an external sustained contact starts the timer, which continues to cycle until the control contact is broken. Full cycle time is the total time range of the timer specified, and may be selected from a large number of available ranges. If desired, the timer can be wired to perform one cycle and stop.

At the start of each cycle, the snap-acting SPDT load switches are in the initial positions specified (or established through adjustment) by the user. As the cycle progresses, each load switch is transferred by its operating cam to open or close its connected circuit at the required time and for the required duration.

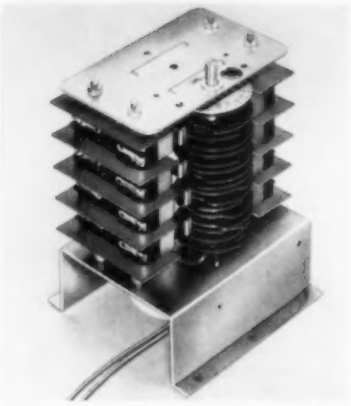
Timing Cam Adjustment

Each SPDT switch is operated by a double cam, one section to close the switch to one contact, the other to close it to the opposite contact. Depending on circuit wiring, either of these actions can "make" or "break" the load circuit. Each section of each cam is independently adjustable through a full 180°, without disturbing any other cam setting, by means of a small spanner wrench furnished with the unit. Adjustment is indicated on a dial which is marked in percent of total cycle time, permitting accurate selection of the desired "make" and "break" points for each load switch.

Features

TIME RANGES — From 1 cycle in 6 seconds to 1 cycle in 48 hours.

LOAD CIRCUITS — From 1 to 3 (Type 511) or from 4 to 8 (Type 521), each controlled by a totally-enclosed quick-make quick-break SPDT switch rated for 20 amperes at 125 or 250 volts AC (non-inductive).



Field-Adjustable Program Timer Type 521

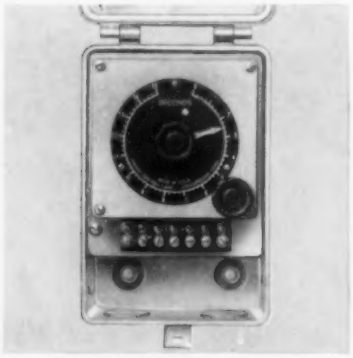
OPERATING TIME — Minimum operating time for each circuit is approximately 1/30 of total cycle time.

ACCURACY — At operating point of any one circuit, 1½°; between any two circuits, 3°.

MOTOR — Cramer high-torque synchronous, for 115 and 230 volts, 25, 50 and 60 cycles. Motors for operation on DC or at other frequencies are available in limited time ranges.

For detailed information and complete specifications, write Cramer Controls Corporation, Box 7, Centerbrook, Conn.

THREE MORE WAYS TO SOLVE YOUR TIMING PROBLEMS

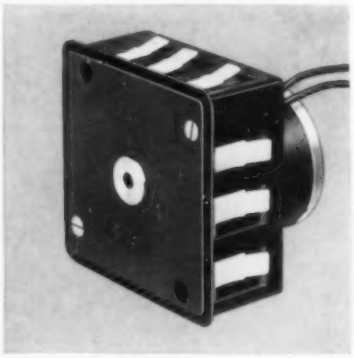


VARIABLE-CYCLE PULSE TIMER TYPE 650

Makes or breaks an electrical circuit for a fixed period or "pulse" of ½ second to 12½ hours, at continuously repeated intervals that are adjustable from ¾ second to 24 hours. By choice of load connection, control can be based either on the fixed pulse time or on the adjustable interval between pulses. Cycling period can easily be changed during operation.

ADJUSTABLE PERCENTAGE TIMER TYPE 610

Makes or breaks an electrical circuit for a variable percentage of a basic fixed cycle time. Desired percentage of total cycle time, for ON or OFF control of the timed device, is adjustable from 4% to 96% in steps of 1%. Total cycle-time ranges from 15 seconds to 24 hours. Internal connections can easily be arranged so that the load circuit is either closed or open for the indicated percentage of the full cycle.



CYCLING TIMER TYPE 571

Provides reliable and inexpensive control of repetitive switching for built-in applications. One through four poles, SPST or SPDT open-blade switches with contacts rated at 30 amperes, each controlled by a timing cam specially cut to user's requirements. 18 standard speeds from 1 rpm to ⅛ rpd, plus many special time ranges.

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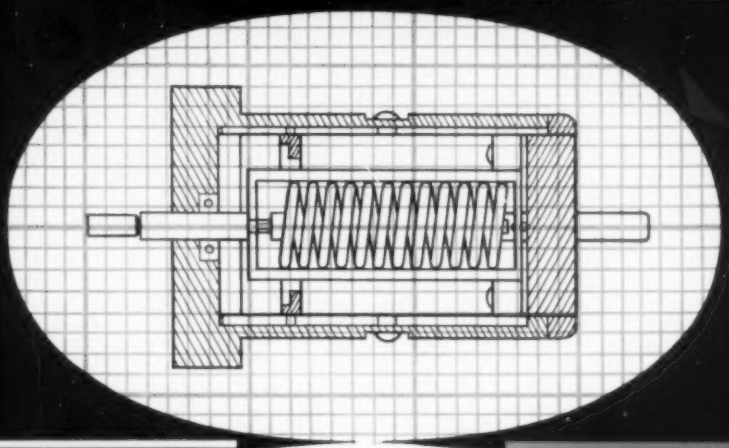
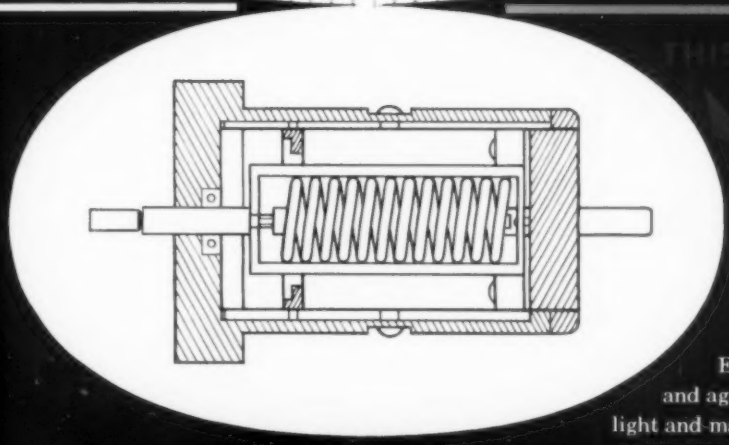


Quickly and accurately rendered to scale with blue grid lines to guide you. Guide lines are on back of drawing surface enabling you to erase and erase without disturbing them.



Blue grid lines have disappeared completely giving sharp, easy-to-read copies.

Try Clearprint's perfect working surface with a 2H pencil—then with a pen. Lines are sharp and clear—Erase and draw the lines again and again. Now hold Clearprint to a light and make reproductions. No ghosts! Then test your present sheet.

Ask our representative or write us regarding Clearprint's revolutionary new "Pre-Print" which pre-prints your basic standards, typical details, title blocks, and bills of material. Their application to your particular needs can save thousands of dollars in drafting and lettering time!

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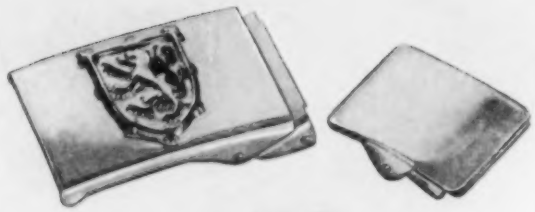
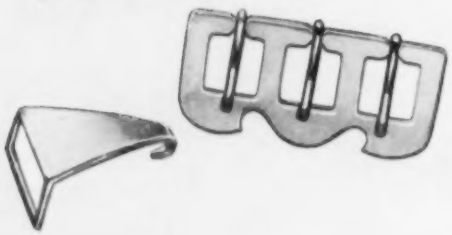


Polishing rejects down from 8% to 1%



Metal Buckles by Domar Buckle Mfg. Co.

Withstands 3-4 time reduction in difficult deep draw

Flower Pot is 4½" high x 5" diameter

CHASE® S-19 PROCESS BRASS STRIP GIVES YOU EXACT "JOB-TAILORED" SPECIFICATIONS PLUS SAVINGS

L&R Metal Products Division of Domar Buckle Mfg. Co. reports reduction in polishing rejects from 8% to 1%, plus additional 5% saving traceable to careful gauge control used in making Chase S-19 Process Brass Strip and Sheet.

Artistic Manufacturing Company says: "Our flowerpot is a tough draw. We draw, reduce 3-4 times, anneal, hammer, polish, then lacquer. Chase S-19 Brass has consistent quality, and never orange peels in spite of the tough handling."

These are two of hundreds of cases where users have made production savings with Chase S-19 Process Brass Strip and Sheet. This Chase exclusive process can provide metal of 40-62 Rockwell B with a "job-tailored" list of properties to meet exact and specific needs. With S-19, you can order *and get* the right combination of elongation, tensile, yield and grain size. And you get still more—unrivalled surface that takes a final finish with minimum buffing, combined with fatigue resistance no other strip or sheet can match. Be sure to ask your Chase Representative how S-19 Process Brass can help you to a better product at lower cost. You can reach him locally, or by writing Waterbury 20, Connecticut.

Chase®

BRASS & COPPER CO.
WATERBURY 20, CONN.
Subsidiary of
Kennecott Copper Corporation

The Nation's Headquarters for Brass, Copper and Stainless Steel

Atlanta Baltimore Boston Charlotte Chicago Cincinnati Cleveland Dallas Denver Detroit Grand Rapids Houston Indianapolis Kansas City, Mo. Los Angeles Milwaukee Minneapolis Newark New Orleans New York (Maspeth, L.I.) Philadelphia Pittsburgh Providence Rochester St. Louis San Francisco Seattle Waterbury

HOW THE SILICONES MAN HELPED...

MAKE THE TAPE THAT FORMS A PERFECT SKIN

Wrap a fully cured tape of this new silicone rubber around a cable . . . in a short time it fuses into a homogeneous mass! Press a molded or extruded piece of this rubber into position and it will stay firmly in place. From research at UNION CARBIDE, the Silicones Man brings you the world's first *fusible*, silicone rubber.

This new product has all the properties usually associated with premium silicone rubber . . . outstanding high temperature performance, good electrical and oil resistance, excellent reversion resistance among them. You can well imagine the many applications in electronics gear, high temperature locations . . . how assembly work will be speeded by "press-in-place" construction. Here is another example of how the specialized knowledge of the Silicones Man has helped solve an "impossible" problem.

Write for data on "Fusible Silicone Rubber" or any of the many other silicones products available through the Silicones Man. Address **Box HP-9706,** Silicones Division, Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. (*In Canada:* Bakelite Company, Division of Union Carbide Canada Limited, Toronto 7, Ontario)

Unlocking the secrets of silicones

Rubber, Monomers, Resins, Oils and Emulsions

UNION CARBIDE TRADE-MARK SILICONES

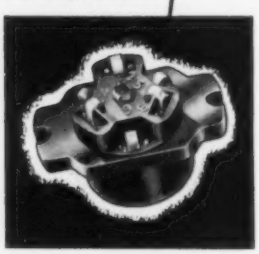
The term "Union Carbide" is a registered trade-mark of UCC.

"THE MOTOR IS PROTECTED AGAINST OVERLOAD BY BUILT-IN THERMOSTATIC PROTECTION"

KLIXON

MOTOR PROTECTORS guard against costly burnouts in GOLF SILENTIUM pumps made in Denmark

KLIXON TYPE CW THREE-PHASE PROTECTOR



The factors which cause overheating in single and three-phase motors are the same everywhere and lead inevitably to the same destructive result unless controlled. That is why you'll find progressive motor and equipment manufacturers the world over specifying KLIXON Inherent Overheat Protected Motors.

The H. HOLLESENS Pump Works of Copenhagen, Denmark, long a user of KLIXON protected single-phase motors, is the first manufacturer in Europe to specify KLIXON three-phase inherent protectors in its product line.

Here's what Manager, Jørgen Aabye, says:

"In our silent circulating pumps for central heating, for garbage grinders and domestic water supply systems, we have for years guarded against motor burnouts with KLIXON *Protectors — first in single-phase motors — now also in our three-phase equipment. The results have been excellent."*

You, too, can get maximum overload capacity with dependable overtemperature protection in the motors that operate your equipment — just specify and use KLIXON inherently protected motors. Write now for the details on KLIXON Inherent Protectors for single-phase and polyphase motors . . . new bulletin PR 1243 available on three-phase motor protection.

METALS & CONTROLS CORPORATION

Spencer Division 3808 Forest Street, Attleboro, Mass.

KLIXON®

GENERAL PLATE

PROFILE ROLLED STOCK

A 3-Way Money Saver

1 Lowers Production Costs

2 Reduces Scrap Losses

3 Reduces Inventories

General Plate's profile rolled stock offers new opportunities to reduce costs in today's quest for dollar-saving methods. Here's some of the benefits you get from General Plate's profile rolled stock:

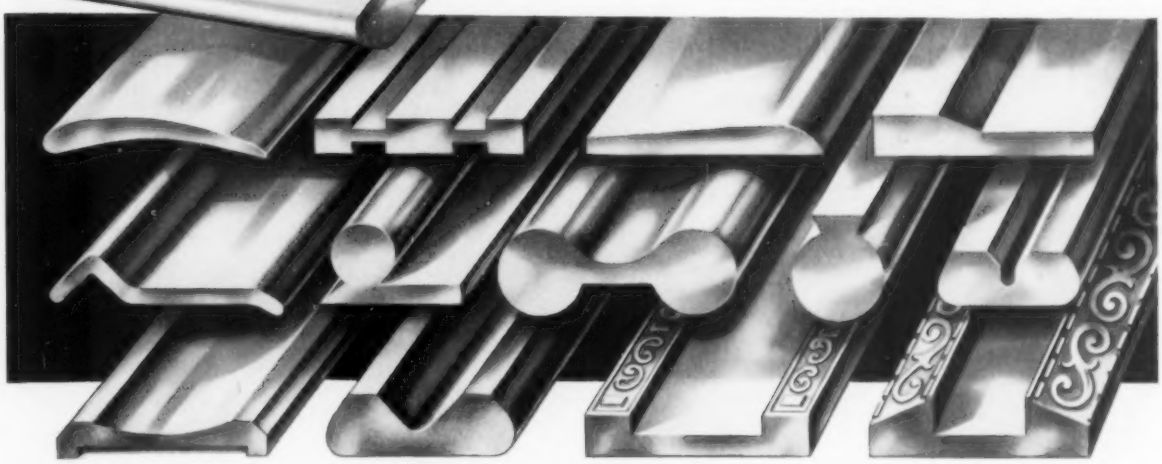
1. Simplified small parts production.
2. Close tolerances in dimensions, contour, and composition.
3. Wide diversification of available metals and shapes.
4. Finished surfaces.
5. Size range from .025" to 3½" wide.

These advantages, plus expert toolmaking — skilled production people — proper heat treating facilities — efficient delivery service — make General Plate a dependable source of supply for your formed stock needs.

Let us figure on your profile rolled stock requirements — if you'll send information to help us quote, we'll be glad to estimate tool and material costs without obligation.

send —

- cross-sectional sketch of drawing and dimensional tolerances
- length of strip and tolerances
- material specifications
- permissible edge curvature and flatness
- surface finish required
- hardness, and
- quantities involved.



You can profit by using General Plate Profile Rolled Stock.

METALS & CONTROLS CORPORATION

General Plate Division — 1008 Forest Street, Attleboro, Mass.

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NOW.. from MUELLER cold·prest® IMPACT

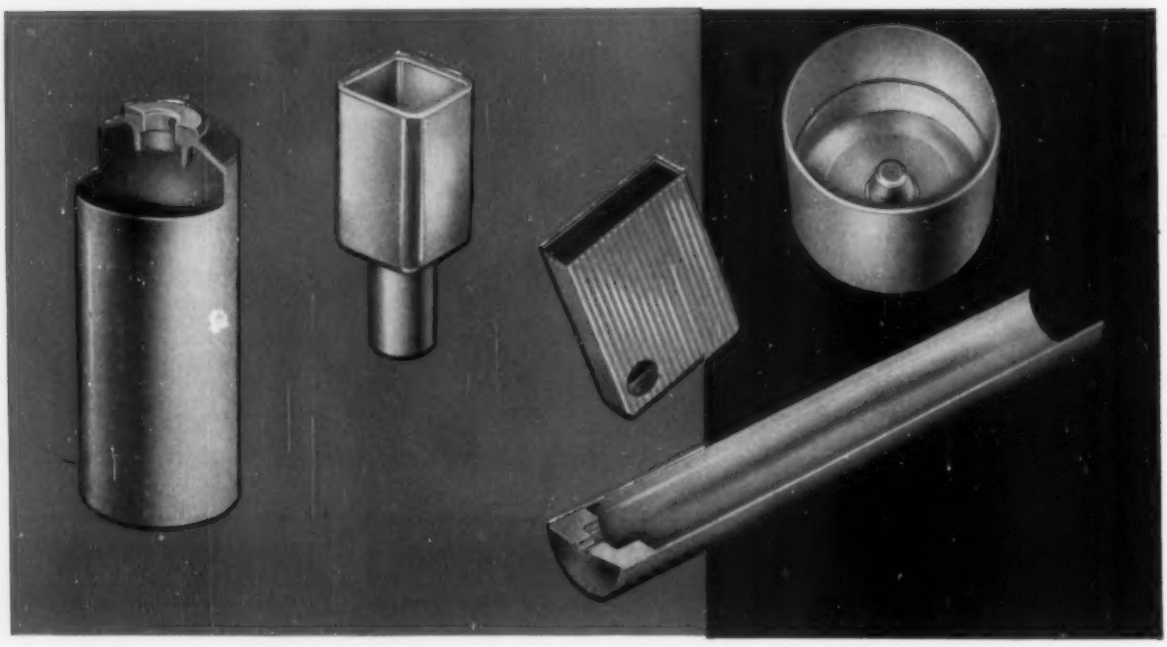
the amazing, new, chipless metalworking method that cuts production costs... ....improves part quality

Cold-Prest Impact Extrusions are here. This amazing new method of producing parts to closer tolerances . . . with better physical characteristics, and with absolutely no waste and at extemely high speed is the greatest development in metal-working in the last 20 years. And it's proving to be the most practical method of manufacturing a staggering number of designs that combine cold forged bases with shells shaped as rounds, ovals or rectangles.

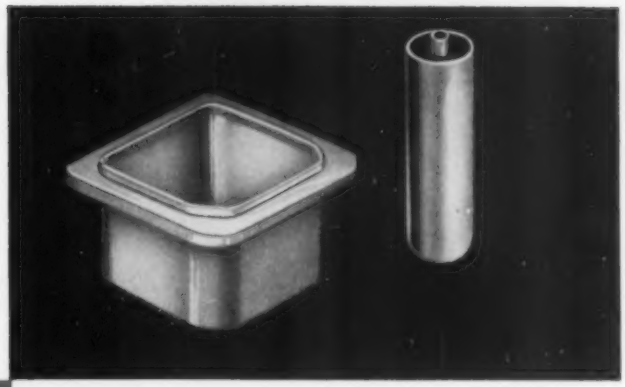
Here are some of the reasons why your company can save money and improve product quality . . . by specifying Mueller Brass Co. Cold-Prest Impact Extrusions. Parts are formed with *no chip loss;* you pay only for the metal that goes into the part. Because of the dimensional accuracy of Cold-Prest extrusions, parts can be held to closer tolerances and many costly secondary machining operations are eliminated. They have better physical properties with actually less metal needed to achieve greater strength.

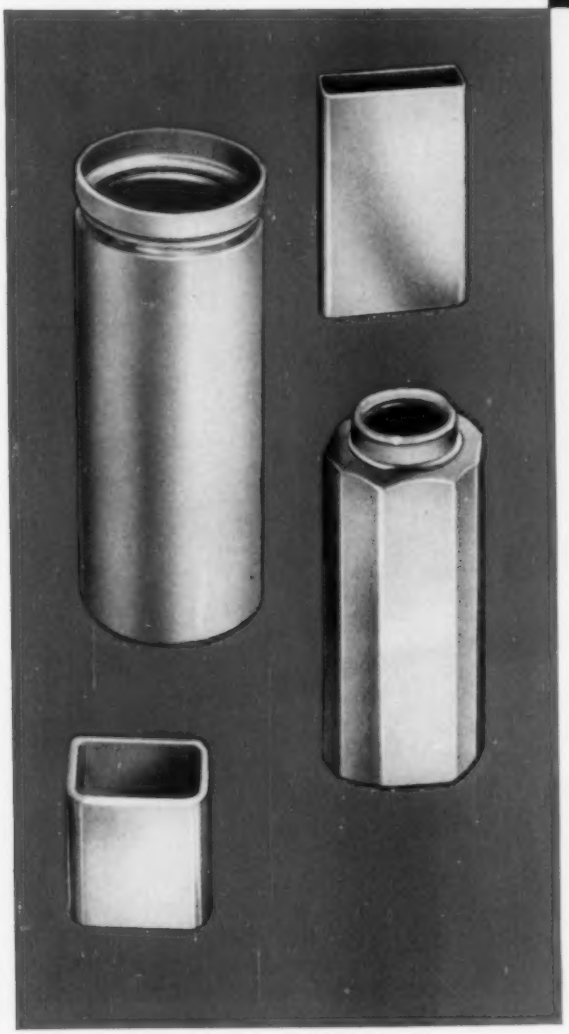
Cold-Prest Impact extruded parts often *reduce or eliminate assembly operations* because products employing several parts can often be made as a single extrusion. Also, complex parts produced by conventional methods requiring costly machining to close tolerances can be made in *A SINGLE OPERATION* as a Cold-Prest extrusion, saving raw material, costs of time, tools and labor . . . as well as assuring a positive leak-proof part.

These are the outstanding reasons why you should consider Cold-Prest Extrusions when you are specifying and purchasing fabricated metal parts. Call a Sales Engineer from the Mueller Brass Co. . . . he will be glad to discuss your problems and answer your questions. Write today for our new 16 page engineering manual on "Cold-Prest Impact Extrusions".



BRASS CO.
EXTRUSIONS





MUELLER BRASS CO. SERVICES mean better designed, better engineered, lower cost cold-prest extruded parts

To produce precision, high quality impact extrusions, Mueller Brass Co. combines all the important factors of design, engineering and production in its Cold-Prest extrusion process. Trained engineers take into consideration such elements as functional strength, finished appearance and proper control of metal flow. Mueller Brass Co. offers this design engineering service to its customers, and engineers are always available for consultation.

Here a die and punch assembly, made to exacting tolerances and with a mirror-like finish, receives a final inspection in the tool and die shop before being sent to the production department. Skilled craftsmen work with the best equipment available to produce these precision tools and dies. Technical skill, modern equipment and complete engineering services are available at no extra cost to you.

MUELLER BRASS CO.

MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

259

PORT HURON 22, MICHIGAN

DE LAVAL IMO PUMPS

are now more versatile than ever

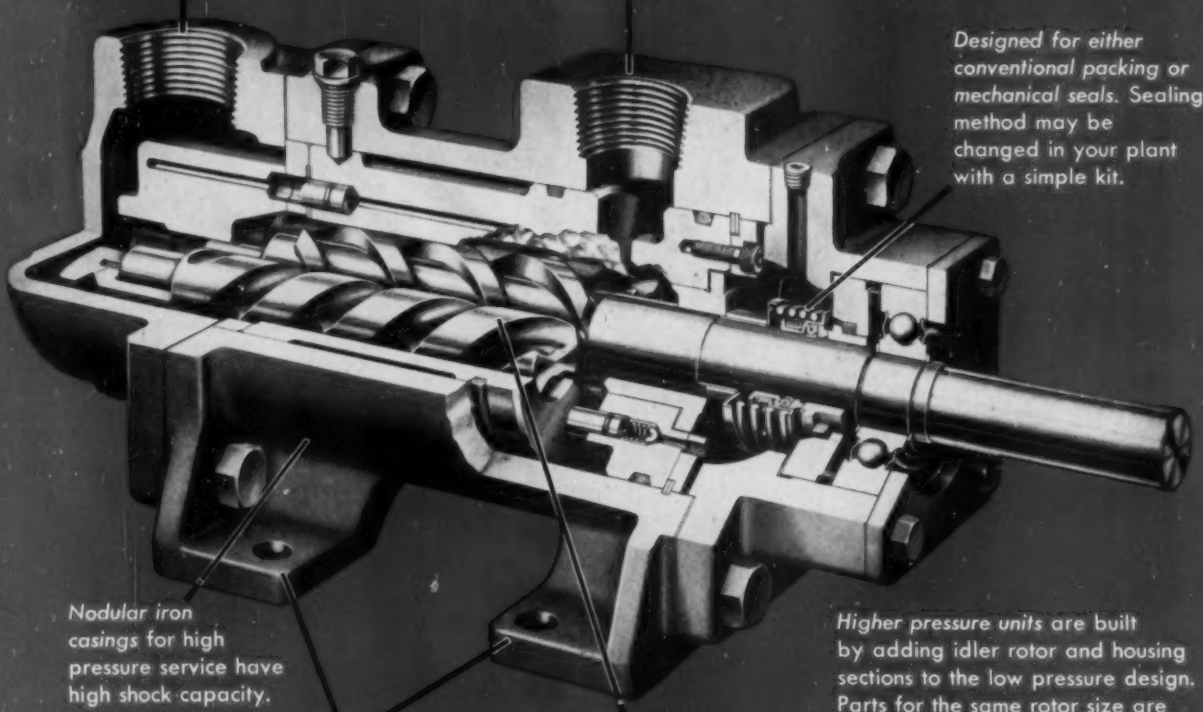
De Laval IMO pumps have proved that they do a dependable job over long years of service. The reason is IMO design simplicity. These constant displacement rotary pumps have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation. There are no timing gears, cams, valves, sliding vanes, or reciprocating parts to wear or become noisy. *Quiet*, compact IMO pumps are excellent for direct-connected, high-speed operation.

In addition to these basic pumping advantages, the improved IMO gives you important new benefits shown in the cutaway illustration below.

Inlet can be rotated to suit installation arrangement.

Discharge flanges are infinitely varied. You can use the most advantageous piping method to suit installation requirements.

DE LAVAL IMO PUMPS can also be used as hydraulic motors.



Designed for either conventional packing or mechanical seals. Sealing method may be changed in your plant with a simple kit.

Nodular iron casings for high pressure service have high shock capacity.

Any position mounting is possible without factory modification.

Higher pressure units are built by adding idler rotor and housing sections to the low pressure design. Parts for the same rotor size are interchangeable over the entire pressure range.

Internal parts are designed as a package so that units can be built into your machines.

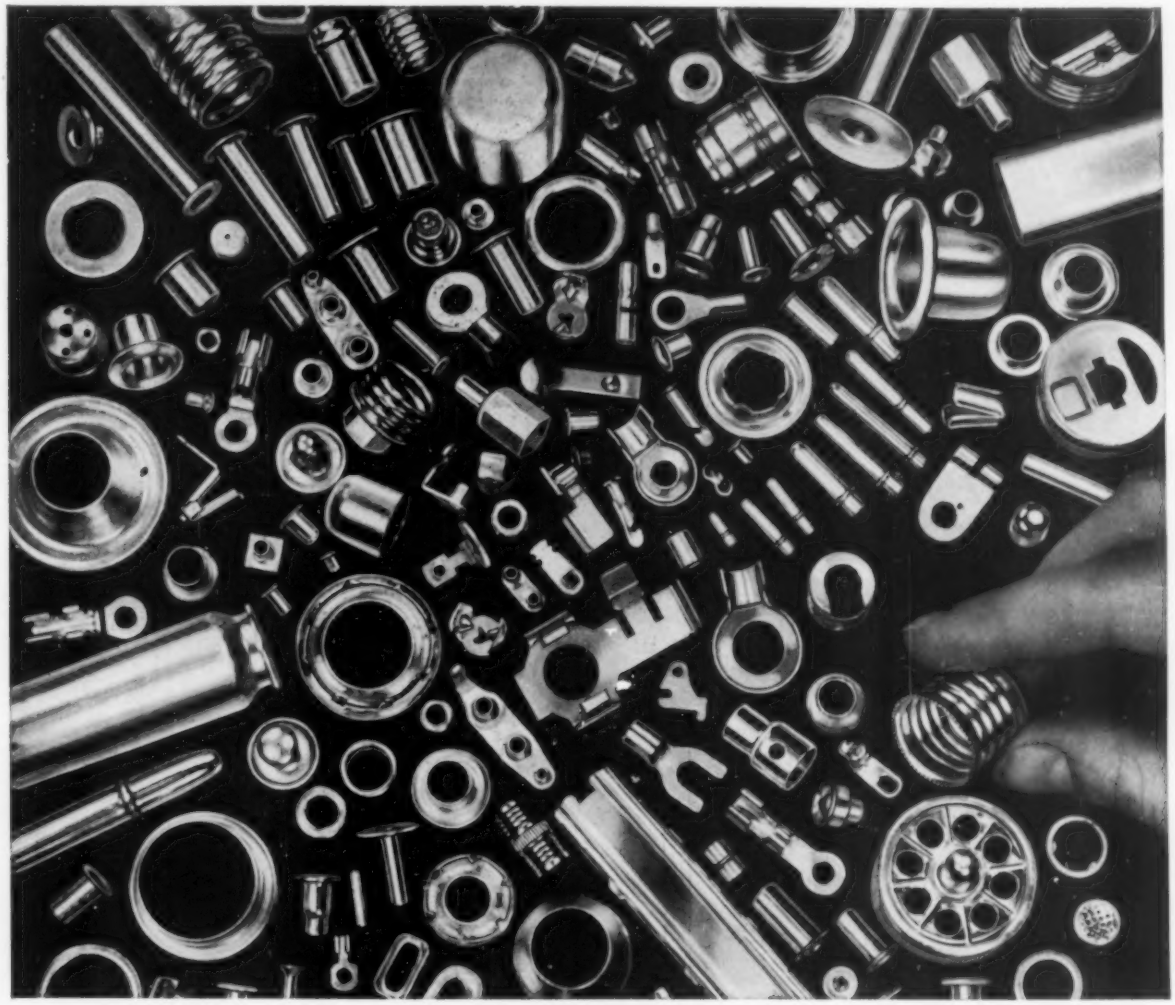
Bulletin 3001 gives data on improved De Laval IMO pumps. Send for your copy today.

DE LAVAL *IMO Pumps*

DE LAVAL STEAM TURBINE COMPANY

801 Nottingham Way, Trenton 2, New Jersey

DL 418



All of these parts were designed to serve a specific function—at a lower cost. Some are made by customer-owned tools.

Pick a part! any part . . . any metal

Then ask us for an eye-opening quotation

These are only a few of the thousands of multiple-plunger and progressive-tool press products we supply to every branch of industry—from simple eyelets to precision electronic components.

We offer a complete design-engineering service based on long experience and specialized production equipment, and are often able to suggest ways and means of using our stock tools to further cut costs.

Simply send us a sample, drawing or description of the parts you need, plus the quantity. The metal can be copper, brass, bronze, nickel silver, nickel, iron, steel, stainless steel or aluminum . . . and in any applied or plated finish you choose.

Send your inquiry to: The American Brass Company, Fabricated Metal Goods Division, Waterbury 20-A, Connecticut.

6852

STOCK PRODUCTS: Write for catalog BG-1, showing a selection of more than 1,000 eyelets and seamless base pins of common sizes and styles, many of which are kept in stock for immediate shipment.

ANACONDA®

Multiple-Plunger Press Products

←CIRCLE 120 READER SERVICE CARD

CIRCLE 121 READER SERVICE CARD

Wherever your hydraulic machinery goes
—recommend Shell Tellus Oil

Its performance and name are the same around the world

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Shell Rimula Oils—for heavy-duty diesel engines

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Shell Alvania Grease—multi-purpose industrial grease

Shell Turbo Oils—for utility, industrial and marine turbines

Shell Dromus Oils—soluble cutting oils for high-production metal working

Shell Macoma Oils—for extreme pressure industrial gear lubrication

Shell Voluta Oils—for high-speed quenching with maximum stability

Shell Tellus Oil is top-rated as both a lubricant and a control fluid for complex hydraulic systems. Its ability to combat oxidation, rust, sludge-formation, wear and foaming has earned it nationwide popularity.

You may be glad to know that the hydraulic-operated equipment you manufacture can now obtain the same efficient protection in other countries of the world. Tellus* Oil is available to your customers abroad. With it they can enjoy the same performance that your domestic customers rely upon.

For more complete information on Tellus Oil, write Shell Oil Company, 50 West 50th Street, New York 20, New York, or 100 Bush Street, San Francisco 6, California.

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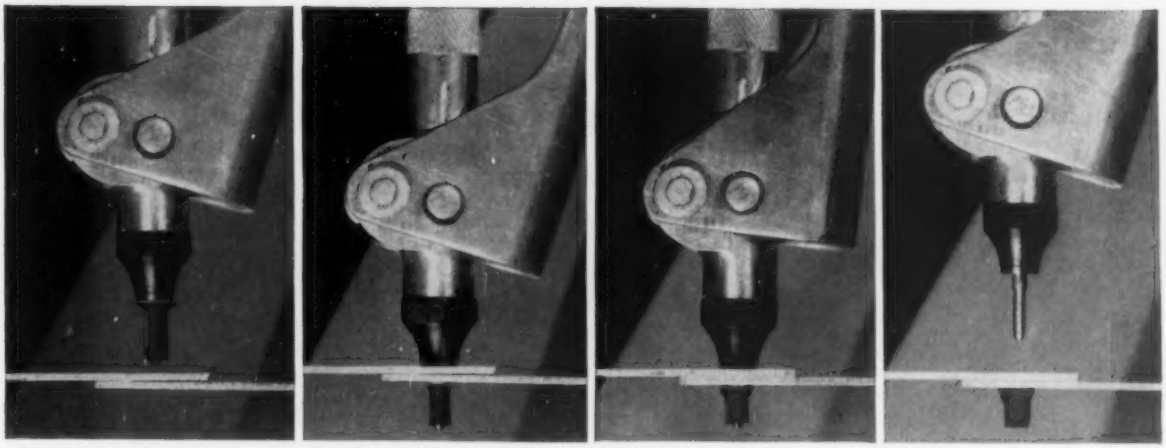
SHELL TELLUS OIL

SHELL

B.F.Goodrich

Rivnuts® fasten thin metal... provide 6 threads in 6 seconds

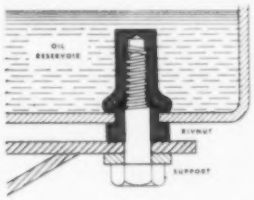


1 Rivnut is threaded onto pull-up stud of heading tool.

2 Rivnut is inserted—head held firmly against work.

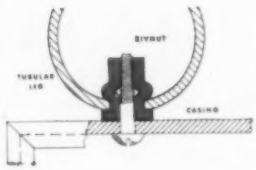
3 Tool lever operates pull-up stud, forms bulge in Rivnut.

4 After upset, Rivnut threads are ready for screw attachments.



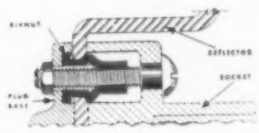
REPLACES BRAZED NUT PLATE

Rivnuts with closed ends are installed in one-tenth the time it took to braze nut plates on oil reservoir tanks. Leaking, warping and thread cleaning are eliminated, and spacer head assures proper positioning of tank on support bracket.



ELIMINATES NUTS AND BOLTS

One worker installs a Rivnut in the tubular leg of a portable barbecue in seconds—provides a firm, accurate nut plate for screw attachment. There are no boltheads to detract from the unit's clean lines. Time is saved, too, in faster knockdown for shipping.



DOES 2 FASTENING JOBS

Rivnuts provide 6-thread nut plate for attachment from either end—or both. In spotlight assembly, Rivnut replaces awkward welded stud for attaching socket. Plug base is attached on other side. Result: fewer operations, lower assembly cost.

B. F. Goodrich Rivnuts—the easy way to cut assembly time . . . costs

Rivnuts, the only one-piece blind fasteners with threads, can be installed by one person from one side of the work—in seconds. Easy installation saves up to 50% of assembly time, reduces production costs. Rivnuts can also improve the appearance of your products and make them easier to use and service.

Rivnuts are made in a variety of sizes and head styles to solve almost any fastening problem. They make tight, dependable seals that resist vibration, stay put so you can assemble and disassemble the product as often as you like without stripping the threads. Welding, tapping and thread cleaning are eliminated. And you can install Rivnuts after enameling without fear of chipping.

B.F.Goodrich Rivnuts have speeded up thousands of fastening jobs. They can do the same for you.

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how Rivnuts fasten *to* and *with*. Explains construction, gives proved applications. Write to B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Department PE-88, Akron, Ohio.

B.F.Goodrich aviation products

T-J spacemaker cylinder

Quality Engineered

to give quality results

with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. IMMEDIATE SHIPMENT in a wide range of styles and capacities, with 64,000 combinations. Write for Bulletin SM 155-3 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVETORS AIR AND HYDRAULIC CYLINDERS CUTTERS CLINCHORS

METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

NEW "SUPER" CUSHION FOR AIR . . . Standard at No Extra Cost!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

ONE PIECE PISTON . . . Standard at No Extra Cost!

NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . Standard at No Extra Cost!

NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

STEEL SHAPED TO CUT COSTS AND IMPROVE PRODUCTS

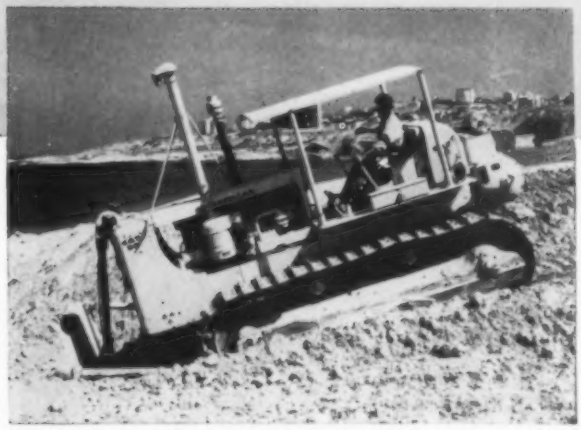
Caterpillar track shoe made from USS Special Section Rolled Steel Bars—a fast, low-cost method for making irregular parts.

Caterpillar makes this complex track shoe . . . from steel already rolled to shape!

The famous Caterpillar Crawler Tractors need a lot of shoes to make up their track—so the cost had to be kept low. To produce the highly irregular track shoe sections by machining, forging, casting or welding was either unsatisfactory, too costly or too slow.

They took the problem to U. S. Steel and a special section hot-rolled steel bar was suggested for the desired shape. The track shoes could then be sheared to the desired length. Three simple punching, shearing and drilling operations completed the job . . . and the shoes were ready for heat-treating and painting.

This method permitted more efficient production of track shoes, reduced the amount of steel needed, eliminated slow, costly machining, and cut scrap losses to rock bottom. The final shoe is strong, tough and long lasting.



Long life in rugged service has proved the quality of these shoes used in the endless track of Caterpillar Crawler Tractors.

Since 1928, Caterpillar track shoes have been produced by the thousands from USS Special Sections. No other production method has been devised that can compare with this for quality parts and low costs.

Why not get the facts on USS Special Sections? This is one way you can make substantial cost reductions and gain increased efficiency, too! United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS is a registered trademark

USS

United States Steel Corporation – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
United States Steel Export Company

United States Steel

Why automotive manufacturers prefer N-A-X® FINEGRAIN STEEL for bumpers

WIDE RANGE OF SHAPES AND CONTOURS
The complexity of today's automotive bumpers demands a steel that provides maximum strength plus unlimited shape and contour possibilities.

FLAT POLISHES TO A HIGH LUSTER
The hardness and fine grain of N-A-X FINEGRAIN renders this steel capable of assuming a high degree of luster at minimum cost.

REDUCES POLISHING COSTS
Bumpers made of polished N-A-X FINEGRAIN suffer no surface disturbances due to coarse grain or strain caused by the drawing process. Preparation costs before plating are thereby reduced.

LESS OVERHANG WEIGHT
Generally, the most difficult bumpers can be made of N-A-X FINEGRAIN with a minimum of 25% increased yield strength over mild carbon steel. This makes possible greater resistance to indentation and substantially decreased overhang weight.

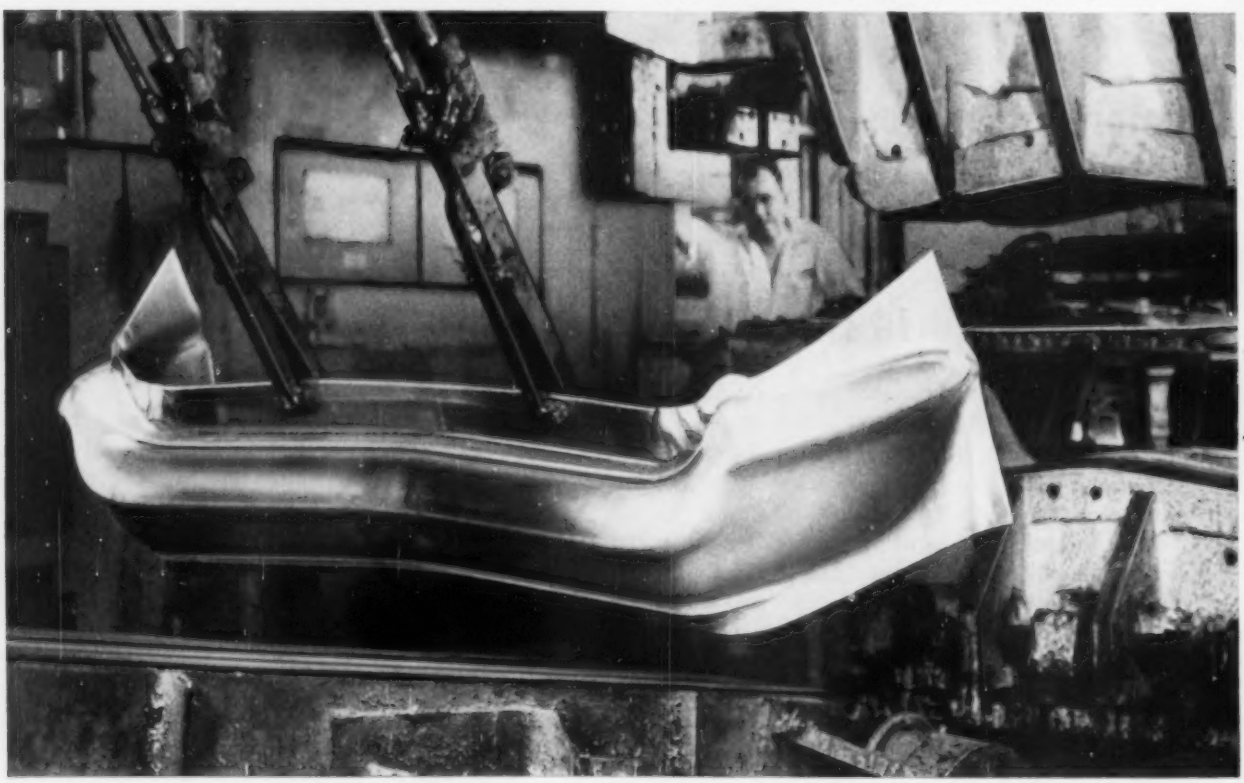
No wonder automotive manufacturers prefer dependable N-A-X FINEGRAIN for the difficult jobs.

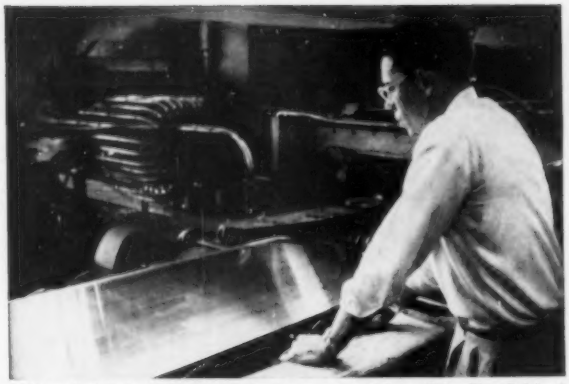
CHECK THESE IMPORTANT ADVANTAGES FOR YOUR JOB:
N-A-X HIGH-STRENGTH steels—both N-A-X HIGH-TENSILE and N-A-X FINEGRAIN—compared with carbon steel, up to 50% stronger • have high fatigue life with great toughness • are cold formed readily into difficult stampings • are stable against aging • have greater resistance to abrasion • are readily welded by any process • offer greater paint adhesion • polish to a high luster at minimum cost.

Although N-A-X FINEGRAIN'S resistance to normal atmospheric corrosion is twice that of carbon steel, N-A-X HIGH-TENSILE is recommended where resistance to extreme atmospheric corrosion is important.

For whatever you make, from steel boats to steel bumpers, with N-A-X HIGH-STRENGTH steels you can design longer life, and/or less weight and economy into your products. Let us show you how.

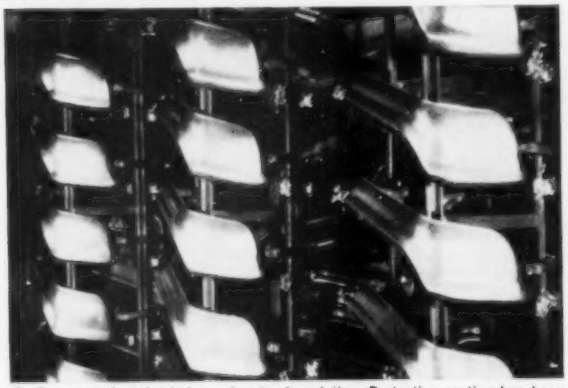
3 Bumper wings, drawn double from N-A-X FINEGRAIN, emerge from press. After splitting and trimming, the protective draw coating is removed. Contoured bumper is then ready for plating without subsequent polishing.





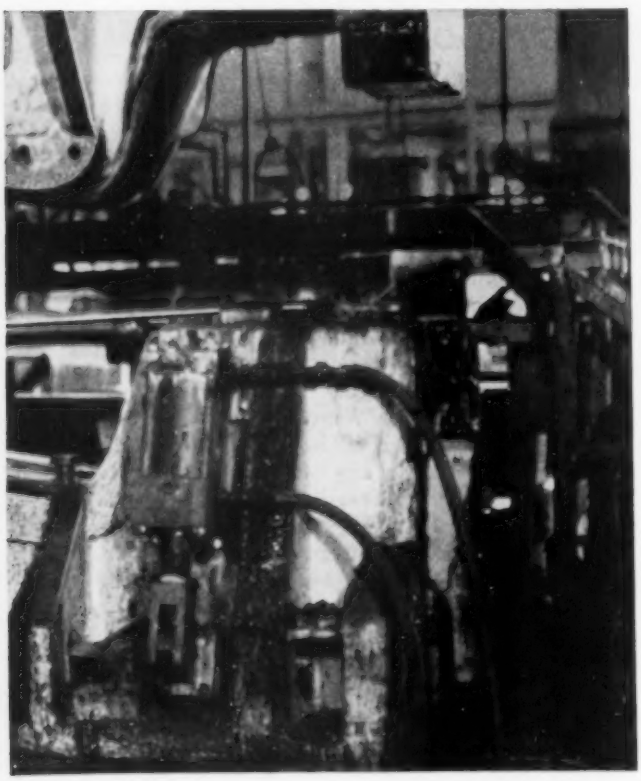
1 Hot rolled N-A-X FINEGRAIN sheets come out of flat polish with a finish of less than 10 microinches.

2 Sheet with protective phosphate and draw coatings comes from coating machine ready for the draw press.



4 Bumper wings loaded on elevator for plating. Protective coating has been removed. Note no surface disturbances occurred after drawing operation.

5 Final inspection after plating. No expensive hand-polishing was required from original flat polish to plating operation.



N-A-X
HIGH-STRENGTH STEELS

Product Development Division, Dept. C-6

GREAT LAKES STEEL CORPORATION

Detroit 29, Michigan • Division of

NATIONAL STEEL CORPORATION

Product Development Division, Dept. C-6
Great Lakes Steel Corporation, Detroit 29, Michigan

☐ Please send me 12-page illustrated technical catalog on N-A-X HIGH-STRENGTH steels.

☐ Please have your representative contact me.

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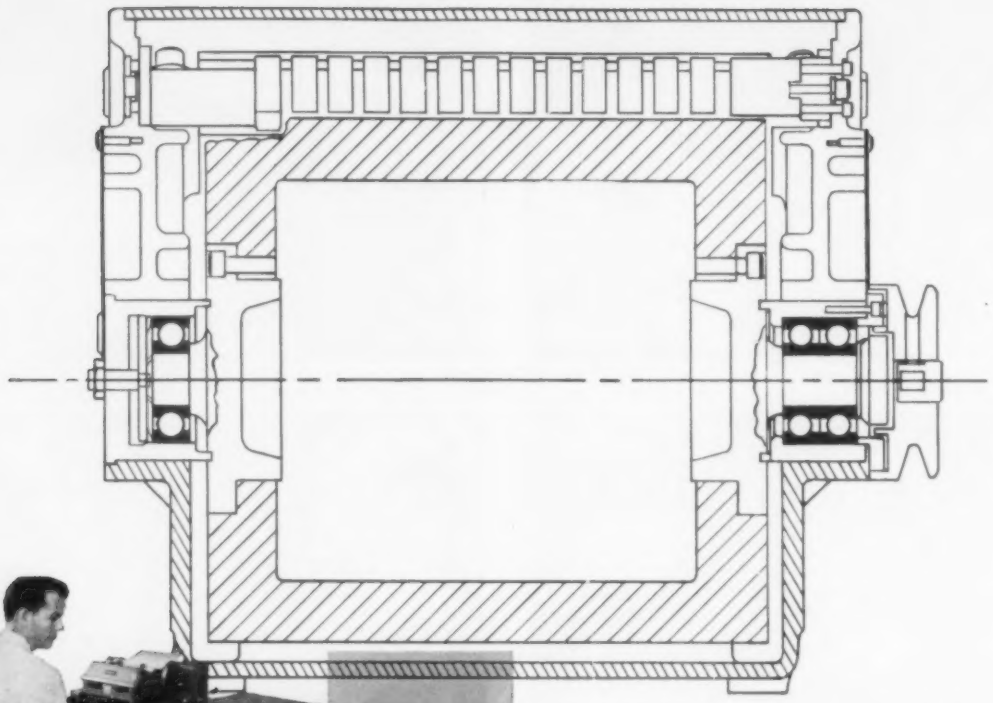


"NO ROOM FOR ERROR"

in design of desk-size LGP-30 digital computer!

Precise performance assured in Librascope's Fafnir-equipped LGP-30

Small as a desk, but it "thinks big"! No less than 4096 words can be recorded on the magnetic memory drum of the new Royal Precision Electronic Computer LGP-30. Moreover, this compact unit, made by Librascope, Inc., a subsidiary of General Precision Equipment Corporation, can be rolled where it's needed and plugged into any conventional wall outlet.

At the heart of this versatile computer, Fafnir super-precision type ball bearings maintain the precise alignment and high sensitivity required of the drum component. Counterbored to take a wide range of thrust, and radial loadings, these bearings provide the rigidity, extremely close-running accuracy, and low torque essential in this exacting application.

Fafnir's contribution to the development of the LGP-30 is another case history example of the high caliber and comprehensive scope of Fafnir design engineering services available to *you*. Take advantage of it when you have a bearing problem. The Fafnir Bearing Company, New Britain, Conn.

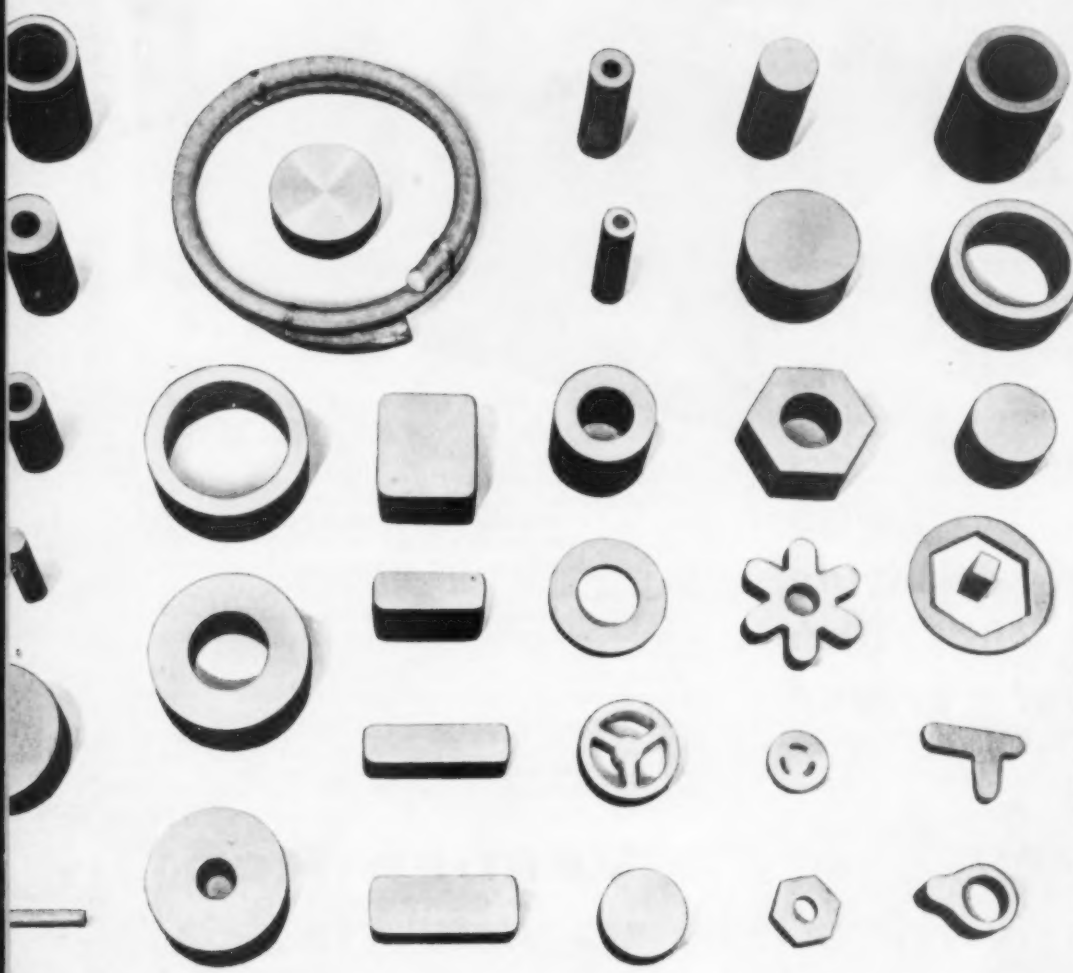
The new Royal Precision LGP-30 is a serial, single address, fixed point binary, stored program digital computer featuring simplified design and ease of operation. The unit is designed to make computer use economical and simple enough for more widespread application.

Fafnir Super-Precision Type Ball Bearings are used in duplex pairs, mounted back-to-back, at the pulley end of the LGP-30 memory drum, and singly at the opposite end. These preloaded, angular-contact bearings, equipped with composition or bronze retainers, are widely used in precision-built mechanisms.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

In continuous lengths: the bronze casting you want in the shape you want! The advantages of custom-shapes in long lengths instead of individual castings. The uniformity and machinability of bronze alloys with no hard or soft spots: no sand, dirt, or dross to dull tools or reduce cutting speeds. The superior physical characteristics of continuous cast bronzes: impact, tensile, and yield strength, and hardness, improved as much as 100% over the same alloys cast by other methods. Asarco will custom cast practically all standard tin-bronze alloys in the shapes, lengths and diameters you need. Asarcon 773 (SAE 660), general purpose bearing bronze, is available from stock in 260 standard sizes, solids and tubes. Check with your local Asarco distributor or write: Continuous-Cast Products Dept., American Smelting and Refining Company, Barber, N. J., Kingwell Bros., Ltd., 457 Minna St., San Francisco. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

CONTINUOUS-CAST DEPARTMENT OF



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AMERICAN SMELTING AND REFINING COMPANY

58-17

ALL NEW!

Veeder-Root Panel-Mounted High Speed Electrical Counters

...with electric resetting in 1/10th of a second

These new Series 1591 Electrical Counters fill the gap between standard and electronic counters for industrial, data processing, or laboratory and scientific uses. They're designed for accuracy and long life at very high speeds (rated at 3000 counts per minute, with extended test-runs up to 6000 cpm).

And they have the unmatched convenience of *instant push-button resetting*, either mechanically right on the machine . . . or electrically from a distance. Panel-groups of these counters can be placed right in your office . . . *and one button can reset an entire panel*. Counters feature large figures, small size, low-wattage coils for continuous duty and other V-R vantage points on which patents are pending.

These new and different counters are the latest evidence that Veeder-Root design and development always keep pace with modern counting requirements. Write for specifications and prices.

Added Evidence that Everyone Can Count on

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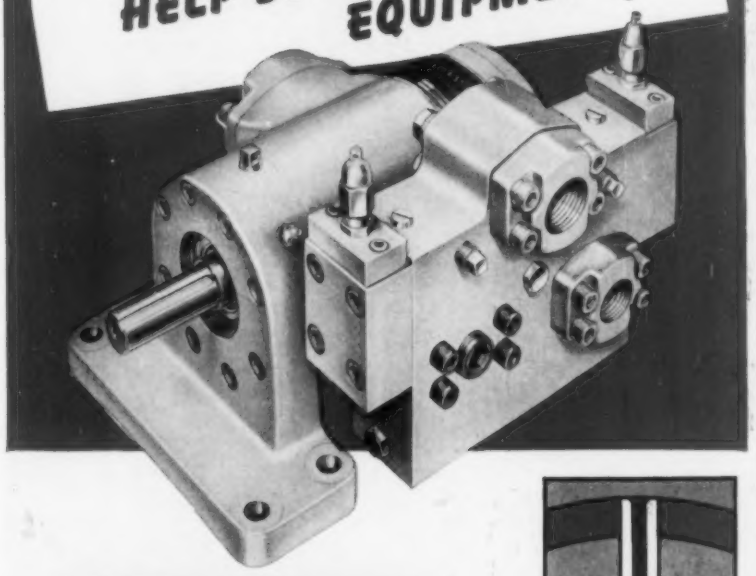
Consider HYDRECO Dual-Vane Double Pumps with Valve Panels from the Standpoint of Their Ability to—

HELP SELL YOUR EQUIPMENT!



HYDRECO

DUAL-VANE CONTROLLED FLUID POWER

Contributes Added Flexibility to Machine Tool Performance

HYDRECO Dual-Vane PF-100 Series Double Pumps with combination relief and unloading valves provide high circuit flexibility through either automatic or external pilot control. For example . . . in a "hi-lo" circuit, large volume delivery is available for a fast traverse cycle. Then, during the feed cycle, when small volume is required, one pump section unloads automatically . . . saving dollars in horsepower! These pumps can also be operated on separate circuits . . . each circuit protected by its own relief valve.

Dual-Vane Pumps can operate *continuously* at 2000 psi and up to 1800 rpm. Their exclusive "Dual-Vane" feature and advanced design combine to assure long, trouble-free performance and maximum simplicity in servicing. Thus, they are a natural choice for a wide variety of high production equipment, including: Machine Tools, Hydraulic Presses, Die Casting and Plastic Moulding Machines, Closing and Clamping Devices and other functions calling for controlled variation in Pump volume.

TWO VANES ARE BETTER THAN ONE

The hydraulically counterbalanced DUAL-VANES in these HYDRECO Hydraulic Pumps eliminate wear-producing loads normally caused by unbalanced hydraulic forces and vane acceleration. DUAL-VANES also maintain MULTIPLE SEALING BARRIERS to slippage and power loss. DUAL-VANES are a patented and exclusive HYDRECO feature.

Member NFPA

The PLUS factors in HYDRECO Dual-Vane Pumps weigh heavily at the sales end—so, WRITE . . . get the facts on Dual-Vane Hydraulic Pumps and Fluid Motors.

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Please send me Bulletin DP-308C fully describing HYDRECO Dual-Vane Double Pumps with Valve Panels.

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Republic's fabricating "Know How" helps Continental Can Company

BEAT THE HEAT AND COLD !

In a specially constructed "torture" chamber, the Continental Can Company, Chicago, exposes thousands of cans and their contents to extreme heat and cold.

The customer wanted rack-type shelving with sliding shelves that could be quickly and easily adjusted to accommodate a variety of can sizes and types, yet still weather the severe changes in temperature. Republic's Berger Division took over the problem, came up with the solution. Through its contract manufacturing facilities and equipment, Berger took the whole job off the customer's hands.

In Berger Plants many sheet steel products are fabricated for other customers and marketed under the manufacturer's brand name.

Berger's large stocks of standard tools, dies, and specialized equipment for punching, shearing, forming, welding, and Bonderizing are available to you. Constant research and development at Berger have resulted in advanced processes and equipment to make your fabricated sheet steel products more attractive, and more economical.

Men of Berger's national sales force will help work with you to solve sheet steel product problems . . . whatever your location. With Berger manufacturing, you get the sales advantage of shipment out of well-located Canton, Ohio. Republic's fabricating "know-how" provides you with the same high quality you see in Berger Division products—lockers, office furniture, shelving, and steel kitchens.

Send a sketch or blueprint with complete specifications. Berger will tell you promptly what their specialized services can do for you. Detailed information is available in Bulletin 1090.

REPUBLIC FILING CABINETS are available in a wide range of styles and sizes to meet any office filing requirement. Drawers coast on cradle-type progressive ball-bearing suspension slides. All steel construction withstands exceptionally hard use. See your dealer—or send coupon today.

SOLVE THE PROBLEM of storing heavy items with Republic Wedge-Lock Steel Shelving. It is specifically designed for high stacking of enormous weights. The joints actually get tighter as more weight is added. Wedge-Lock Steel Shelving provides maximum loading in minimum floor space. Shelves can be easily adjusted — whole units can be converted or combined to suit changing needs. It can be easily and quickly assembled. Send coupon for full information.

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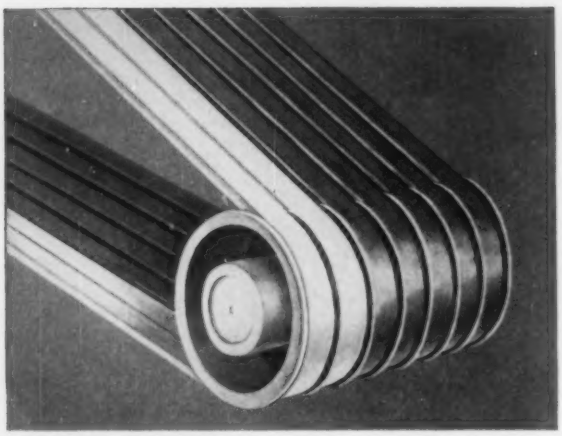
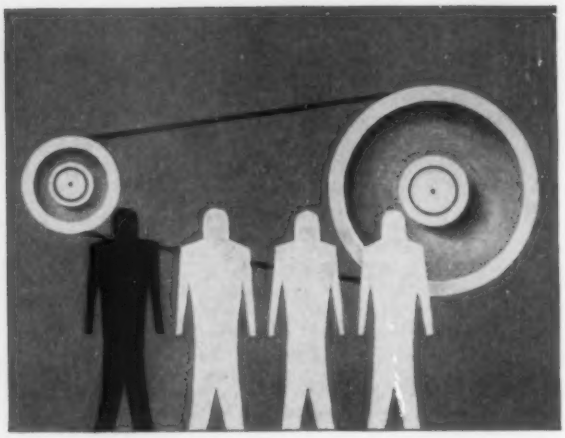
Why V-belts reinforced with DACRON give versatility in design, economy in maintenance

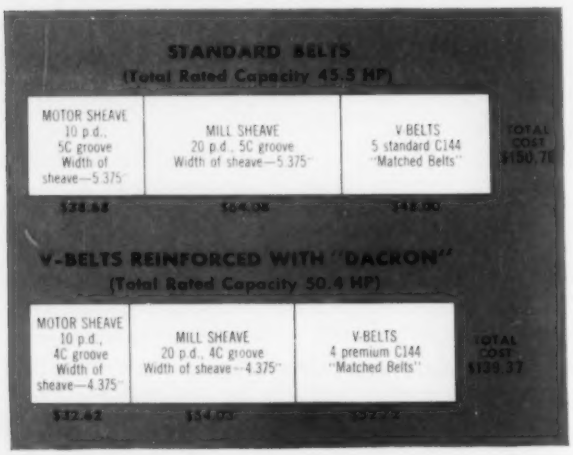
REG. U. S. PAT. OFF.



SPACE-SAVING DESIGN. The extra strength of V-belts reinforced with Du Pont "Dacron"* polyester fiber satisfies the demand for more compact, more economical belt drives. Designers find that fewer and smaller belts and sheaves can carry the load. In a typical case, 5 belts made with "Dacron" did the work of 7 conventional belts.



LESS MAINTENANCE. Stronger, longer-wearing V-belts reinforced with "Dacron" are made to operate continuously under severe shock loads without costly maintenance expense. They stretch less, have longer flex life . . . eliminate the excessive cost of frequent downtime for belt adjustment . . . a big saving in operating expense.


STANDARD BELTS
(Total Rated Capacity 45.5 HP)
MOTOR SHEAVE 10 p.d., 5C groove Width of sheave—5.375"
MILL SHEAVE 20 p.d., 5C groove Width of sheave—5.375"
V-BELTS 5 standard C144 "Matched Belts"
TOTAL COST $150.7[illegible]
$28.68
$64.08
$48.00
V-BELTS REINFORCED WITH "DACRON"
(Total Rated Capacity 50.4 HP)
MOTOR SHEAVE 10 p.d., 4C groove Width of sheave—4.375"
MILL SHEAVE 20 p.d., 4C groove Width of sheave—4.375"
V-BELTS 4 premium C144 "Matched Belts"
TOTAL COST $139.37
$32.62
$54.00
$52.75

LOWER DRIVE COST. Compare cost and capacity of V-belts reinforced with "Dacron" against standard belts. You'll find that belts made with "Dacron" have increased horsepower capacity, give lower initial drive cost, easier upkeep . . . in every way a far greater dollar-for-dollar value.

"Lasted 52 times longer than regular V-belts," reports a user of belts made with "Dacron". Despite continuous rugged use, only one belt change was necessary in five years' operation. "Dacron" yields slightly under high impact—but resists stretch. And the low moisture regain of "Dacron" —only 0.4%—assures dimensional stability to changes in humidity . . . less time spent in matching belts.

For the next drive you design or install, consider the advantages of V-belts made with "Dacron". Du Pont makes the "Dacron" used by belt manufacturers in producing their finest-quality V-belts. E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Department, Wilmington 98, Delaware.

*"*Dacron*" *is Du Pont's registered trademark for its polyester fiber.*

DU PONT

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V-BELTS OF "DACRON" transmit more horsepower . . . stand greater shock loads . . . give longer flex life . . . give greater opportunities for machine-design improvement.

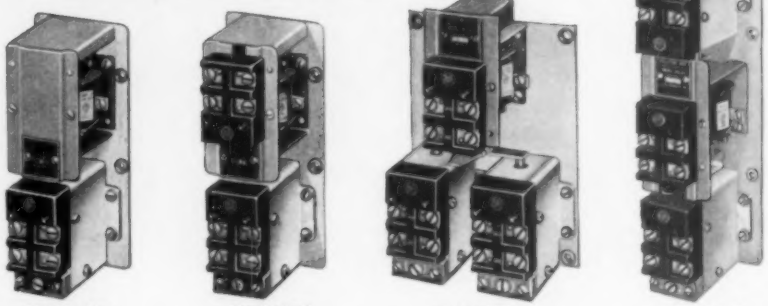
AMONG DESIGN ENGINEERS . . . ALLEN-BRADLEY IS THE PREFERRED CONTROL!

THE "SIGN" OF trouble free TIMING RELAYS!

Pneumatic Timing Relays

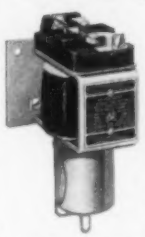
BULLETIN 849

These versatile timing relays are available in a variety of types for either "on delay" or "off delay." Delay time is adjustable from 1/20 to 180 seconds with an accuracy of ± 10%. Maintenance free silver alloy contacts. Additional auxiliary contacts easily added. A.C. or D.C. operation.



STANDARD UNIT | AUXILIARY CONTACTS ADDED | TWO TIMING UNITS | COMBINED ON-OFF TIMER

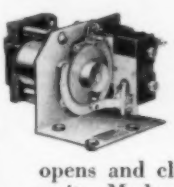
Fluid Dashpot Timing Relays



BULLETIN 848

For applications where reliability is more important than accuracy. As the viscosity of the silicone fluid does not vary with temperature, the timer's accuracy is ± 15% from −30°F to +120°F. Can be easily adjusted from 2 to 30 seconds.

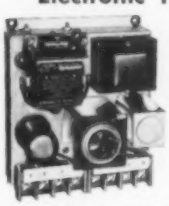
Motor Driven Timing Relays



BULLETIN 850

Driven by a Telechron motor, this timer alternately opens and closes two switch units. Made to provide 2, 3, 4, or 6 operations per minute on 60 cycles. Running and drift time on both contact units are easily adjustable.

Electronic Timing Relays



BULLETIN 852

An accurate and flexible A.C. timer, designed for frequent operation. Can be recycled rapidly over long periods. Time delay is dial adjustable over a range of 20 to 1. Repetitive accuracy ± 2%. Eight units provide time delay of 0.025 to 120 seconds.

This broad line of timing relays carries the traditional Allen-Bradley trademark of *quality* that stands for trouble free operation. The rugged construction and maintenance free, silver alloy contacts have made them first choice among men in the field . . . engineers, consultants, and contractors. You just cannot go wrong when you specify Allen-Bradley control . . . by name!

Allen-Bradley Co., 1329 S. First St., Milwaukee 4, Wis.
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ALLEN-BRADLEY
MOTOR CONTROL
QUALITY

Enlarged 75 times, screw-machined aluminum bushing shows finer precision than the grooves of the L-P record on which it rests.

What the designer conceives . . . aluminum achieves!

0.040-INCH DIAMETER ALUMINUM BUSHING TO HOLD L-P RECORD PLAYER NEEDLE

Designers: Fidelitone, Inc.; Jensen Industries
Screw Machine Operator: Walter Precision Company

The sensitive diamond or sapphire needle used in modern L-P record players must be held by a precision bushing that is soft, but at the same time very strong.

SOFT—to permit the needle to be inserted by gentle pressure.

STRONG—to hold the needle firmly in precise alignment through years of use. In addition, the holding piece must be non-magnetic and light weight.

To best fit these conditions of the bushing design, aluminum was selected. But because the smallest readily-available aluminum rod was ⅛-inch size, they still had the problem of grinding down to a center size of 0.045 before manufacturing the bushing.

Their solution? . . . call Kaiser Aluminum screw machine design and operator specialists. Kaiser Aluminum, besides drawing the rod to 0.045, also *straightened* the coiled aluminum into 10-foot rods.

This material was held to a plus or minus .0005 inch, making it possible to maintain concentricity and finish the part to these dimensions: Diameter 0.040; Overall Length 0.050 to 0.055; Inside Hole Diameters 0.0145 and 0.0165. The smallest O.D. is 0.027 to 0.028, making a wall thickness of only 0.0065.

The manufacturer now gets four times as many parts from the same amount of metal—about 36,000 parts per pound—at half the former cost!

Kaiser Aluminum specialists are immediately available to offer design and production assistance for *any* screw machine problem that you may have. Call the Kaiser Aluminum sales office or distributor listed in your telephone directory.

Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.; *Executive Office*, Kaiser Bldg., Oakland 12, Calif.

FOR THE COMPETITIVE EDGE, GO ALUMINUM

KAISER ALUMINUM

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Multiple-bend discharge tube for refrigeration compressor is fabricated economically on Bundy-designed fixtures. Seven bends are put into a 7" length of ¼ x .028" Bundyweld Tubing in just one semi-automatic operation.

Only Bundyweld Tubing could take the stress ...only Bundy could mass-produce the part!

This refrigeration-compressor discharge tube graphically illustrates the unique physical properties of Bundyweld® Tubing . . . and the skill of Bundy® fabrication experts.

Seven bends in just seven inches sets up terrific stresses—too many for ordinary tubing. Yet Bundyweld takes this punishment with ease . . . still stays *leakproof by test!*

Because Bundyweld is double-walled from a single *steel* strip, it's extra-tough . . . has high bursting strength and great resistance to vibration-fatigue. Result: Bundyweld has become the standard of the refrigeration industry; and it's also used on 95% of today's cars, in an average of 20 applications each.

See what you can do with Bundyweld Tubing! Our engineers will help out at any design-stage in the development of your product, from blueprint to assembly. In many cases, they'll have suggestions on how to make a part faster . . . or at lower cost.

And when the design is firmed up, turn it over to Bundy's skilled fabricators and relax. Using Bundy-designed machines and fixtures, they will mass-produce your parts at low unit-cost. Then they'll package your parts carefully . . . deliver them right on schedule — clean, bright and ready to use.

Whatever your tubing needs, Bundyweld Tubing and Bundy services can pay off for you. Find out more. Call, write or wire today!

BUNDY TUBING COMPANY • DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, ENGLAND, FRANCE, GERMANY, AND ITALY

Bundyweld starts as a single strip of copper-coated steel. Then it's
. . . continuously rolled twice around laterally into a tube of uniform thickness and passed
through a furnace. Copper coating fuses with steel. Result . . .
SIZES UP TO ⅝" O.D.
Bundyweld, double-walled and brazed through 360° of wall contact.

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

THERE IS NO REAL SUBSTITUTE FOR

BUNDYWELD® TUBING

DOUBLE-WALLED FROM A SINGLE STRIP

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LUBRIKIT . . . An assortment of 95 oil cups of 29 different types. Gits sales records show these oilers are most used for replacement and maintenance. Contents of each separate bin are clearly described on Inside Cover.

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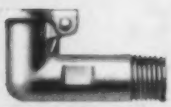
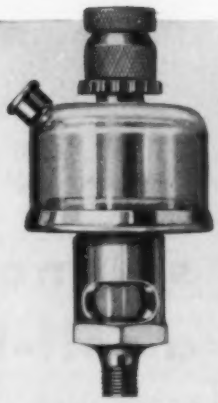
Style GB — No. 527
Ball Valve



Style L — No. 1204
Brass Elbow (Threaded)



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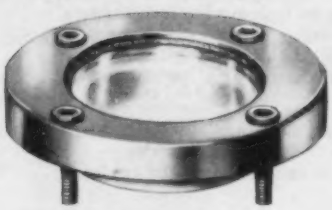
GEAR CASE GAUGES



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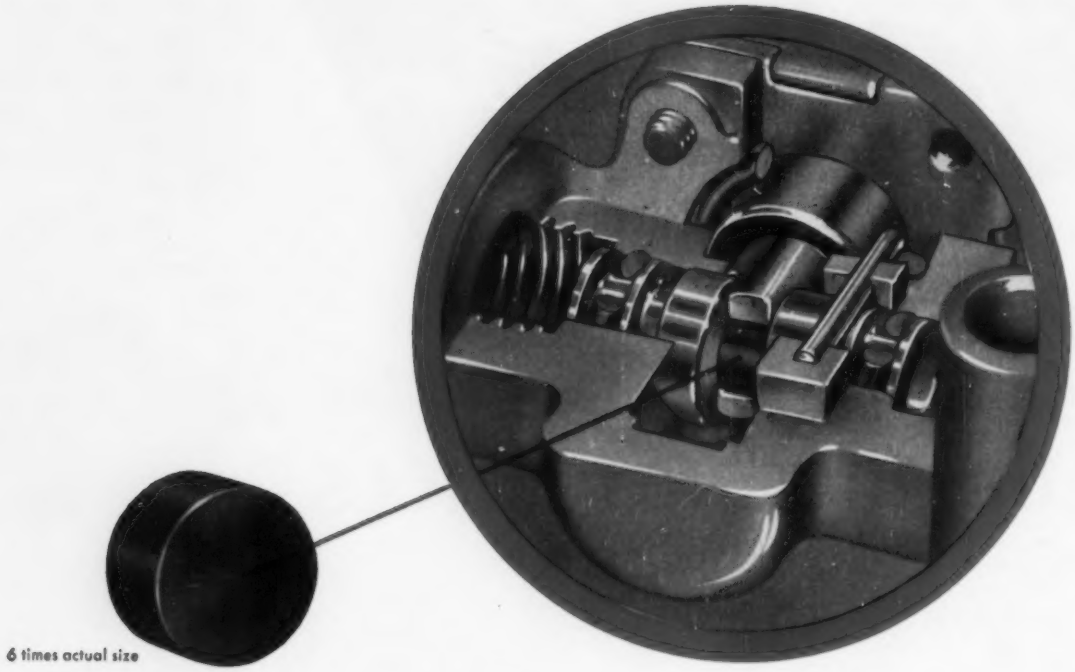

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PERSPECTIVES

in design and development . . .

Keeping Track of Information

Hearings before a Senate subcommittee of the Committee on Government Operations, to discuss the possibility of creating a Department of Science and Technology, received some interesting testimony on the problem of technical and scientific information storage and retrieval. As the proposal now stands, the Bureau of Technical Service will be transferred to the proposed new Department and "will have complete responsibility for the development of a science information program, using all of the facilities of the Federal Government which operate related programs; to acquire scientific literature; and to establish facilities to collate, declassify, translate, abstract, index, store, retrieve, and disseminate information essential to the development of scientific and technological programs. . . . ."

One estimate of the cost to industry and Government for present "inadequate and cumbersome information processing facilities" is $1 billion a year. Merrit L. Kastens, Assistant Director of the Stanford Research Institute, said that ultimately the cost must be borne by the economy as a whole. And, that a system for doing the job right would not cost a great deal more, and even may cost a great deal less. "The possible economic savings," he continued, "through the elimination of the duplication of research and development effort and through the acceleration of the rate of technological progress, which an adequate technical information system would make possible, is extremely difficult to estimate quantitatively."

A survey of a group of industrial laboratories doing work for the Department of Defense resulted in an estimate that 30 to 85% of the research and development work duplicated work already done elsewhere because of the lack of good channels of technical communications. One government research administrator said that because of the difficulty in searching the records for previous work related to a particular field, it is no longer economical to make a literature search for any research problem in which the experimental cost will be less than $100,000. When smaller programs are involved, it is usually cheaper to go into the laboratory and start from scratch.

Efficiency of Research?

According to one spokesman who made his own survey, the efficiency of research is 15%. The other 85%? Ten percent is duplication of material already prepared; 35% is lack of information, or work men did that they would not have done had they known the literature; the remaining 40% is either the lack of proper definition of goals, or the lack of proper understanding.

The total cost of research and development in the US is currently running along at the rate of 2% of the gross national product and is increasing at a rate faster than the gross national product. As D. C. Hilty, Manager, Research Information Div., Metals Research Labs., Electro Metallurgical Co., Union Carbide Corp. said, "This situation is a natural consequence of scientific and technical progress, which continually adds to the complexity of R & D programs. It implies that the R & D programs may be in danger of growing excessively to the point where they require a disproportionately large share of income for support, or they may lose productivity, or both. The effect on progress could be most serious. This cost must be reduced if we are to compete in a world and avoid a technological ceiling."

—Paul Anderson

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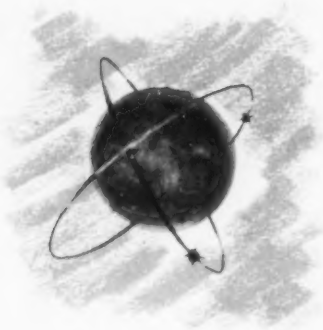
Product Engineering **HORIZONS**

August 18, 1958



a Dog-gone MOUSE

Foreign engineers rarely told me jokes in Europe–there is potential danger in translation. But I'll never forget one day on the way to the noon meal, when a Russian engineer said suddenly, "I understand the reason you have not yet launched a satellite containing a dog is that you are having some trouble breeding a small-enough dog."

Our first animal-carrying rocket, you will recall, contained a mouse, bearing out the Russian story. It also reminds one of the old quotation, "The mountain labored, and brought forth a mouse."

The important fact, however, is that a 6000-mile flight was successful, not whether the mouse was recovered.

Another European engineer first told me that the Russians too had their aborts. An early Soviet rocket landed in Brittany, according to his story. Fragments were taken to the research center "Onera" at Venissieux near Lyons, but nobody could identify them. They were stowed away in a cupboard for later study–and identified suddenly when Sputnik I orbited.

Now a newspaper report says the Russians have had 30 aborts in launching their three sputniks, a ratio which, if true, makes ours look very good by comparison. This is understandable if reports are correct that the sputnik vehicles are essentially heavy and crude devices by comparison with Vanguard or Jupiter.

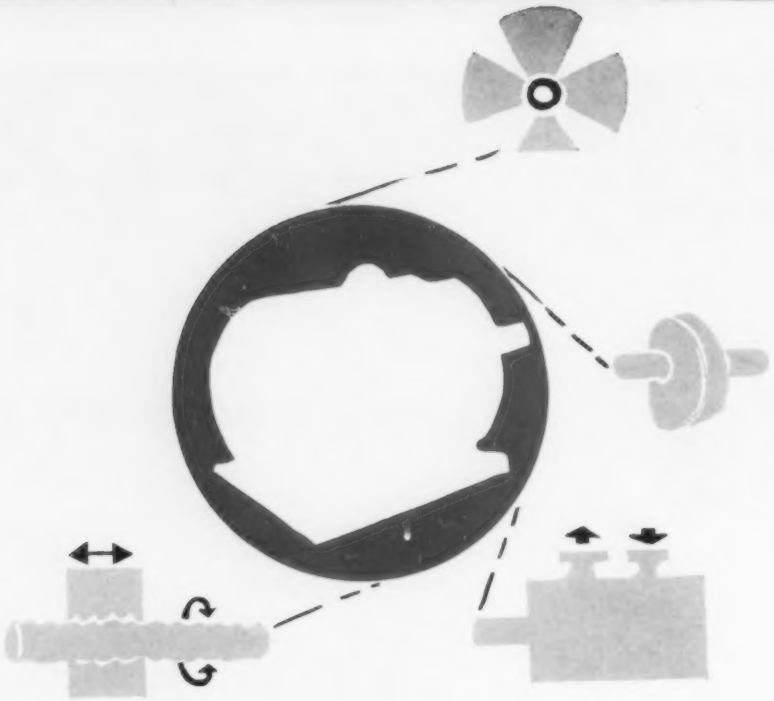
General observation of Russian products indicates that they tend to be heavier than ours, because the USSR has not progressed as far as we have in miniaturizing and in utilizing the ultimate strength of sophisticated alloys. Their economy is still noticeably in the "quantity" stage. This might well influence even such high-priority devices as the sputnik vehicles.

The point is that there are always at least two approaches to a problem, one the tentative, probing, scientific attack, the other the hard-bitten, bulldozing, empirical one. Either–or both–may accomplish the objective. The danger is that the layman may be misled into believing that mere massiveness or size is the better answer, that the ultimate in achievement is bigness.

This is well-illustrated by the stories credited to Texans. Everything there is reputed to be the biggest, widest, heaviest. But what will they do now, with a new state 2½ times as big as Texas? They'll either have to annex Mexico, or arrive at a new set of values, based on the objective rather than on the approach.

If the real objective for example, is to find out the effect of rocket transportation on a living being, a mouse may serve as well as, or better than, a dog.

L. J. Haugeman



Let the load be your guide when selecting POLYPHASE MOTORS

First things first—recognize characteristics of the driven load before shopping for a single-speed motor. These tables match load characteristics with available motor designs . . . in terms of torque, slip and duty cycle.

CHARLES C. LIBBY, Manager, Electrical Dept., Fairbanks, Morse & Co., Fairlawn, N. J.

The tables accompanying this article go right to the heart of the problem of selecting a polyphase motor. They focus on the type of load the motor will have to handle. This is putting first things first—the opposite of starting with a motor and then trying to match it with load requirements. Once the need is matched with motor type in terms of torque, slip and duty cycle, it is then easy to determine required rating by conventional methods.

Among polyphase motors, only the single-speed types are considered here because they are the most common. Before using the tables, the nature of the driven load must be established, and NEMA (National Electrical Manufacturing Association) standards for available motors must be understood (Tables I and II).

Load applications fall into two general categories: Table III for essentially constant speed at all loads; and Table IV for all others, where the speed either must or may deviate from constant speed. Nearly constant speed loads require nearly synchronous (low-slip) motors that have less than 5% drop in speed from zero to full load. Other loads usually require high-slip motors.

Driven-load torques in the tables are specified in percent full-load torque of driving motor rather than in lb-ft. Advantages are: (1) a single torque-percentage figure applies to complete range of similar designs; (2) ratio of load speed to motor speed can be changed without revising percent of load torque; and (3) load-torque description is in same terms as motor-torque standards. Static "breakaway" torque is that required to start rotation of motor and load from a standstill. Dynamic "starting" torque is that required to maintain rotation immediately after breakaway. "Peak" torque is the max instantaneous required from the motor to drive the load over the most severe peak. Motor max torque must exceed this value.

Load duty cycle means the sequence of operation

TABLE I—PERFORMANCE LIMITS FOR SQUIRREL-CAGE POLYPHASE MOTORS

(based on NEMA Standard MG1)

TORQUE OR CURRENT CATEGORY (FULL VOLTAGE ON MOTOR)	MOTOR TYPE BY DESIGN LETTERS (MG-1 11)				
	A	B	C	D	F
	Limitations (or applicable section of MG1)				
Breakdown (max) torque MG 1-4.12	MG 1-4.12			Same as locked-rotor in MG 1-4.11	MG 1-4.12
Pull-up (accel.) torque MG 1-4.13	= or > 70% of locked-rotor in MG 1-4.11. Min is 100% full-load torque			No standards	
Locked-rotor or starting torque MG 1-4.11	Normal		High		Low
Starting or locked-rotor current, amp MG 1-4.09	In excess of MG 1-4.09	Standard low per MG 1-4.09			Very low per MG 1-4.09

TABLE II—TWO STANDARDS OF SLIP FOR SQUIRREL-CAGE POLYPHASE MOTORS

$$\% \text{ Slip} = \frac{\text{Synch. Speed—Actual Speed}}{\text{Synch. Speed}}$$

Source of Standards	Motor rating, 60-cycle speeds	LOW SLIP			HIGH SLIP				
					DESIGN D				
		Design A or B	Design C, 3 hp and up	Design F, 30 hp and up	High-speed punch press	Deep-draw press	Frequent reversing service	Elevator or hoist	Torque motor
Commercial	1–200 hp 1800–450 rpm	2–4	3–5	2–4	5–8	8–13	8–20	15–20	15–50
NEMA MG 1-1.11		<5*		<5	5 or more			No standard	

* For > 10 poles (< 720 rpm synchronous at 60 cps) slip may be slightly > 5%

required by load. Some examples are lifting, start-stop service, and torque drives that do not rotate continuously.

Torque, current and slip developed by motor are defined in Tables I and II. Max or "breakdown" torque is max developed by motor between zero and full-load speed. Accelerating or "pull-up" torque is min developed by low-slip motor and usually occurs at about 20% speed.

NEMA design letters have been established for some single-speed polyphase motor types on bases of torque, current and slip. Designs "A" and "B" have low starting torque, low rotor resistance and low slip; Design "D" has high starting torque, high rotor resistance and high slip; Design "C" has two squirrel-cage windings to start like "D" and run like "B." Design "F" specifies low starting torque and very low starting current, but has been largely supplanted by industrial types with slightly higher starting current (about 45% full-load current), and giving improved starting torque. Wound-rotor slipring motor with external variable-resistance grid can be used for high and low slip; it has good characteristics for continuous service at varying speeds. It also can isolate much of

TABLE III—FOR THESE CONSTANT-SPEED LOADS . . . . . THESE LOW-SLIP MOTORS

(Where drop in speed from zero to full-load is < 5%)

% RATED TORQUE REQUIRED BY FRICTION AND WORKLOAD			EXAMPLES	SUGGESTED NEMA MOTOR TYPE AND ALTERNATE	WHY EACH MOTOR TYPE?
Break-away	Start	Peak			
25–40	10–25 ↑ Easy starting	130–150	Non-positive-displacement blowers, compressors, fans, and pumps; mixers (liquid); and motor-generator sets	Design B	Accepted standard for full-voltage starting
				Design A	More efficient, lower slip than B (but usually costs more)
				Design C, or slipring	Min starting current; reduced-voltage starting
				Design F (or equiv.) >30 hp only	Min starting current and full-voltage starting
			Small machine tools (also see Table IV)	Design A	Accepted standard for some new ratings of NEMA totally enclosed motors
				Design B	Accepted standard for other enclosures and ratings
40–70	25–50 ↑ Medium starting	130–150	(unloaded start) Conveyors; line shafts; mixers (powder); positive-displacement pumps and compressors	Design A or B	Accepted standard for full-voltage starting
				Design C or slipring	Min starting current and reduced-voltage starting
100–150	75–125 ↑ Difficult starting	130–175	(loaded start) Circular saws (large); other examples same as medium (above) except higher torques required	Design C	Accepted standard for full-voltage starting
				Slipring	Min starting current
65–200	50–175	200–*250	Mill equipment such as line shafts (rubber, flour), mixers, metal rolling mills, pulverizers (start unloaded), crushers (no flywheel), and hammer mills	Design C	Accepted standard for high starting torque
				Design A	Allows full-voltage starting for chippers, shredders, rotary vacuum pumps
				Special	Steel mill, jaw crusher
				Slipring	Min starting current, all applications
← Loaded start and high peak →					

* Some jaw crushers and rolling mills to 350.

heat in grid circuit, thereby increasing motor life or allowing smaller size than squirrel-cage design.

LOW SLIP IS COMMON

The majority of typical motor applications require fairly constant speed (Table III). Design "B" is the most frequently chosen low-slip squirrel-cage design partly because power companies prefer a low-starting-current motor for across-the-line starting.

High-starting-torque loads require Design "C" motors . . . they give highest starting torque per ampere of any low-slip design. High peak- or breakdown-torque load with starting torque below 75% requires Design "A" motor with clutch drive, or a larger rating of Design "A" or "C" motor. A slipring motor will provide both high starting and high pull-out torque.

When load requires max pulsating torque, consult manufacturer. Torsional vibration and surges of current in motor may necessitate special rotor construction and bracing of stator windings. Normal pulsating loads usually require Design "C" motors.

Starting at full voltage is recommended for light, medium and heavy starting loads in Table III if the proper motor is chosen. However, starting current to a squirrel-cage motor can be reduced by lowering the voltage or using only part of the winding. It is wise to check with the appropriate power company for limitations on current. A slipring motor in low-slip service is usually started on full voltage, with variable resistance in rotor circuit for starting only. If required, motor can develop up to 100% torque at start with current not over 10% full-load value. Because cost and maintenance of slip-ring motors are higher, first consider suitability of the squirrel-cage type.

TABLE IV—FOR THESE TROUBLESOME LOADS . . . . . THESE HIGH-SLIP MOTORS

(Where constant speed is not primary goal)

APPLICATION	TYPE OF DUTY	EXAMPLES	SUGGESTED NEMA MOTOR AND ALTERNATE. ALL SQUIRREL-CAGE EXCEPT AS NOTED	WHY EACH MOTOR TYPE
Lifting	Full-load start; frequent start and reverse; intermittent service	Elevators	Class AH-1, 15–20% slip	Low-amp start, high torque, quiet
			Class AH-2, slipring	Same, but adjustable speed
		Small cranes and hoists	Hoist-type, 15–20% slip	Low-amp start, high torque, short-time duty
		Large cranes and hoists	Crane type, slipring	Adjustable speed
Plugging (switching terminals) **and other reversing**	Light-load start; frequent start and reverse	Automatic machine tools	Design D	Accepted standard for full-voltage start
			Slipring	>25 hp
Inertia starting	Occasional start; high load inertia	Centrifuges, extractors, rotary kilns	Design D	Accepted standard for full-voltage start
			Slipring	>25 hp
			Design B	With clutch drive
Flywheel drive	Severe pulsating load torque, may be random or constant freq. (10–60 rpm)	Punch presses	Design D, 5–8 and 8–13% slip	Accepted standard for full-voltage start
			Slipring	>25 hp
Torque drive	Stalled continuously	Lever or linkage actuator	Torque motor, rated % stall time (squirrel-cage)	No overheating at stall; high locked-rotor torque
	Stalled intermittently	Clamp or screw actuator; valve operator (limited rotation)		
	Torque $\propto \frac{1}{\text{speed}}$ both forward (motor) and reverse (brake)	Drive for reel or spool (stalled occasionally)	Torque motor stalled 50% of time max	Same as stalled type except torque varies inversely with speed forward and reverse
		Brake for reel or spool (free running)	Torque brake, 5–20% slip	Accepted standard
	Frequent start-stop; fast accel.	Drive for rapid traverse, feed or index	Torque motor, 20–50% slip	High starting torque, low starting current

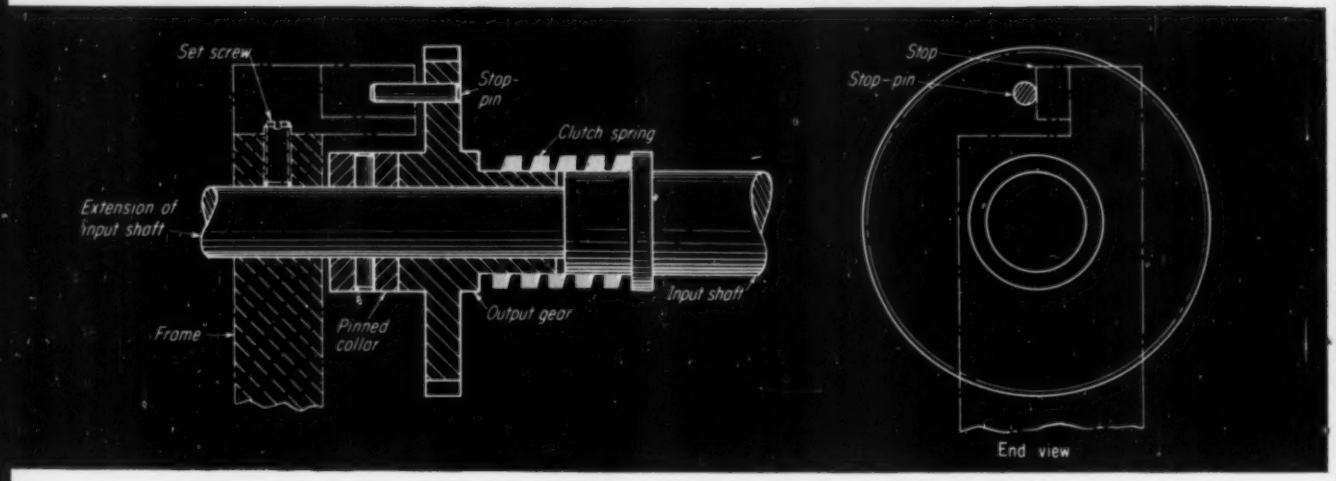
HIGH SLIP FOR DIFFICULT DUTY

High slip is not necessarily a quality in itself, but results from higher designed-in rotor resistance . . . put there to give high torque at low speed (Table IV). Design "D," the most common, is available with different slip values. Definite-purpose NEMA Class AH-1 and -2 motors meet elevator, crane and hoist requirements. AH-1 is high-slip squirrel-cage; AH-2 is slipring. Torque motors are squirrel-cage with high torque at low speed.

Design "A" or "B" low-slip motors are lower priced than high-slip Design "D," and sometimes more economical with high-slip loads—if a centrifugal or magnetically controlled clutch can be added between motor and load. The motor accelerates before load, reducing time of high-current drain.

REPRINT of this article can be obtained for your reference file by checking E39 on one of the Reader Service cards bound in this issue. For other reprints available see "Current Reprints" listing in this issue on page 122.

EDITOR'S NOTE: Selecting motors is not, of course, simply a matter of reading tables—preliminary tests and calculations are necessary. Over two dozen articles in the past few years have shown how to meet this need, but space here does not allow listing them. The roundup—title, issue date, and brief content description of each—will appear in a future issue.



you can whip the backlash in SPRING CLUTCHES

Spring clutches are noted for their unpredictable backlash. Nor does it help to tighten spring tolerances. But these two simple spring modifications, developed by the author, eliminate the trouble.

JOSEPH KAPLAN,
Project Engineer, Fairchild Camera & Inst. Corp., Syosset, N. Y.

It is no longer necessary to assume that the backlash in a spring clutch is beyond control. This belief has often caused the clutch to be overlooked when a design called for minimum backlash. Here are two simple, inexpensive ways to modify the clutch so that its backlash is entirely eliminated–and with it disappears a frequent cause of lost motion in indexing operations, delayed engagement of loads, and overstressing of the spring under shock loads.

A spring clutch transmits torque in one direction only–it overrides when reversed. Its spring need not be fastened at either end; an interference fit will do. Rotating the input shaft in the direction tending to wind the spring will cause the spring to grip the shaft and transmit torque. Reversing the input unwinds the spring, and it overrides the shaft with a slight drag.

Even if a spring is made with close tolerances, there may be considerable backlash. For example, three coils of a clutch spring in the bridging area have an inside diameter 0.001 in. larger than the end coils. For a ½-in.-dia shaft the backlash will be:

$$\left(\frac{2\pi\ (\Delta d)\ N}{D}\right)\left(\frac{180}{\pi}\right) = \frac{2\ (0.001)\ 3\ (180)}{0.5} = 2.16°$$

As it is difficult to manufacture springs to inside-dia tolerances of 0.001 in., large variations in backlash must be expected from the standard spring clutch.

Tapered Springs Give the Answer

To eliminate backlash, the spring should have an interference moment (see "The How and Why of Backlash," on next page) which increases gradually from the free end to the bridging coil. This avoids forcing the spring to leave the shaft under the influence of the drag torque, and backlash is thereby eliminated.

There are two ways to accomplish this: least costly is to employ a tapered-wound spring. The smaller-dia side is forced over one shaft and the larger dia over the other. When the clutch overruns, the spring end with the larger dia slips over its shaft. A 1° to 3° taper is usually sufficient.

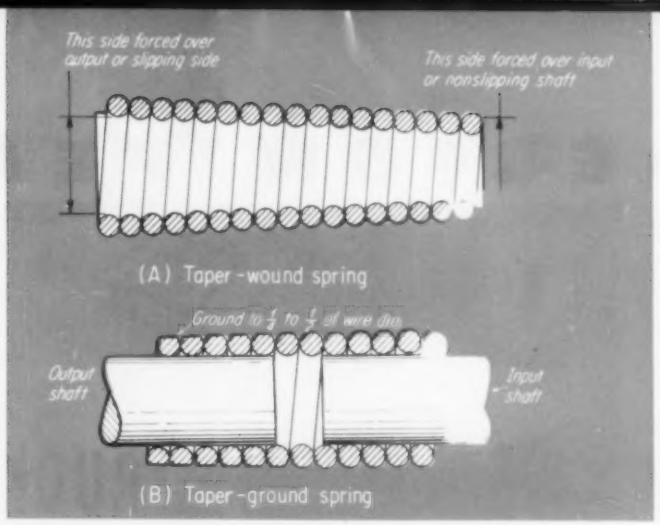
The other design solution, more effective but also somewhat more expensive, is to taper-grind a standard spring from the free end to the bridging coil. The change in thickness of the spring wire produces a pronounced interference-moment gradient, which easily compensates for diametral variations in springs.

Both these methods have been applied to clutches in instrument applications and found to reduce backlash to the point where it could no longer be detected.

◀ How to measure backlash . . .
in spring clutches. Jig is shown in phantom line; spring clutch in solid line. Clutch spring, made of square wire, is not fastened at either end but has an interference fit with the shafts.

SYMBOLS

D — Shaft dia, in.
M — Interference moment of spring, lb-in.
N — Number of coils
T — Drag or friction torque, lb-in.
μ — Coefficient of friction
Δd — Variation of inside dia of spring, in.
ϕ — Angle of wrap of spring wire, radians


This side forced over output or slipping side
This side forced over input or nonslipping shaft
(A) Taper-wound spring
Ground to ¼ to ½ of wire dia
Output shaft
Input shaft
(B) Taper-ground spring

Spring modifications . . .
eliminate backlash by gradually reducing gripping power of spring over the output shaft. Design in (B) is preferred, though slightly more costly than (A).

THE HOW AND WHY OF BACKLASH

Backlash can be defined and measured with the aid of a simple jig. Clamp input to the frame and rotate output gear in the overriding position until its stop-pin contacts the stop on the frame. Then reverse rotation and apply a light torque to the shaft to make the spring grip. The amount of rotary movement, measured by noting the amount of clearance between the two stops, measures backlash in the clutch.

Backlash is almost entirely caused by drag on the coils. Spring tension, and strain caused by slippage, are too small to be factors. Also, tightening the tolerances between spring and shaft does not help much. Experiments show large variations in backlash for springs seemingly of identical dimensions—it is nearly impossible to eliminate backlash by merely tightening the tolerances.

Drag in Spring Clutches

Backlash is affected by drag, and drag is affected by: interference moment, angle of wrap, and coefficient of friction. The equation relating these factors is:

$$T = M\,(e^{-\mu\phi} - 1)$$

For most spring clutch designs, $e^{-\mu\phi}$ approaches zero; so drag torque for all practical purposes equals M. Consequently, slip occurs on the spring and shaft combination which has the smaller interference moment.

When the clutch is stationary, reaction forces between spring and shaft are uniform over length of the spring, and directly proportional to M. When the clutch is driven in the overriding direction, reaction forces of small lengths of spring are proportional to $Me^{-\mu\phi}$, where $\phi = 0$ at free end of the spring. The largest reaction forces occur here. They diminish as the angle of wrap of the spring, measured from the free end, increases. Thus, for a coefficient of friction of 0.2 and an angle of wrap of four coils, the spring-shaft reaction diminishes to less than 1% of the reaction at the free end. The remaining coils on the input shaft have virtually no reaction.

How Drag Affects Slippage

It has been assumed here that M is uniform throughout the spring length, and the drag torque, by virtue of the above equation, cannot exceed this interference moment. Consequently, the spring maintains contact with the shaft from the free end to the bridging coil (even though with negligible pressure over a fair portion of its length) and no backlash occurs when the clutch is reversed to transmit torque.

However, in actual construction, several coils in the bridging area are likely to be somewhat larger in diameter than coils near the free end. Thus, when the clutch is stationary, the interference moment of the spring near the free end is larger than at the bridging area. To produce slip in the overriding direction, drag torque must attain a higher value than the interference moment available to the coils near the bridging area, thus forcing the coils to expand until their moment equals the drag torque. This unwinding process creates the backlash which has to be taken up when direction of clutch rotation is reversed.

REPRINT of this article can be obtained for your reference file by checking No. E38 on one of the Reader Service cards bound in this issue. For other reprints available see "Current Reprints" listing in this issue on page 122.

EDITOR'S NOTE: Spring clutches employed in indexing operations can bring a rated load up to full speed in less than 2 millisec. See "Spring Clutches for Faster Response," Apr 14, p 57.

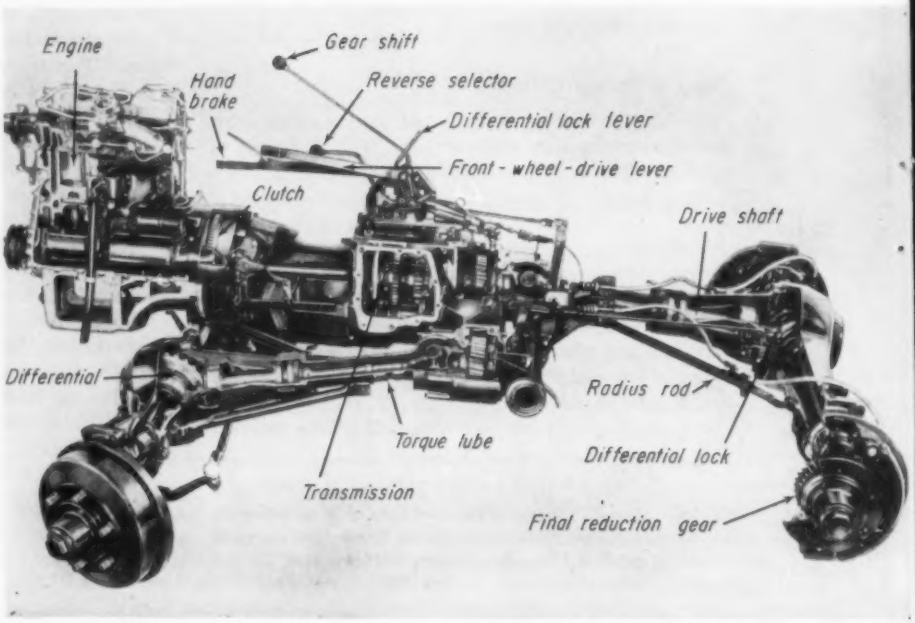
TRUCK SPROUTS POWER TAKE-OFFS

Despite its appearance, Unimog is a multipurpose vehicle that's as much a tractor as a truck. It has power take-off at four locations and drives over 150 accessories. All driving forces are handled by the unitized engine-transmission-axle assembly.

The portable power is packaged in the form of a small, 3,960-lb truck that can run up to 33 mph in sixth gear and go over rough terrain. In road travel it gets up to 23 mpg. Unimog was developed by Daimler-Benz AG, Gaggenau, W. Germ., and is now marketed and serviced in the US by Curtiss-Wright Corp., South Bend, Ind.

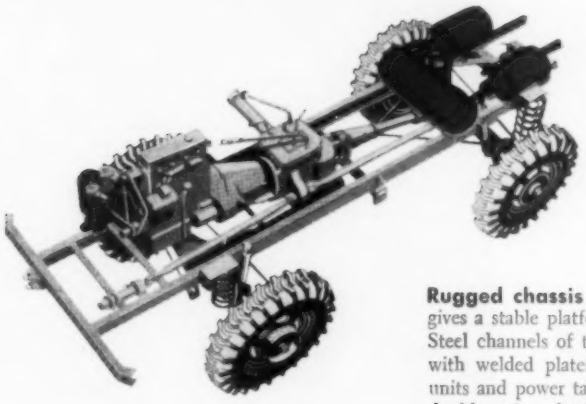
Unimog's simple body . . . is constructed of flat steel sheets. With windshield folded over sloping hood and canvas top stowed, maximum visibility is provided for operating accessories. Weathertight doors, side curtains and heater protect driver at all temperatures, and closed steel cab is available. Sides of rear platform may be removed for mounting accessories, or entire platform replaced by a swivel mount for hauling semitrailers.

Engine, clutch and transmission . . . bolt together solidly for a rigid mechanical backbone. The 4-cylinder diesel engine produces 35 hp at 2550 rpm. Governor regulation prevents overloading in continuous operation. The single-plate clutch controls power to a transmission with six forward and two reverse speeds. Reverse lever permits changing first and second forward speeds to reverse. Power flow from the transmission is through universal joints and splined drive shafts to differentials at each axle. Torque tubes and radius rods on the drive shafts transmit all driving loads directly to transmission and engine. The differentials can be locked to prevent wheel slippage in loose soil, mud or snow. Final reduction gearing at each wheel steps-up the axles for increased road clearance. Provided are 4-wheel hydraulic brakes, plus mechanical brakes on rear wheels.

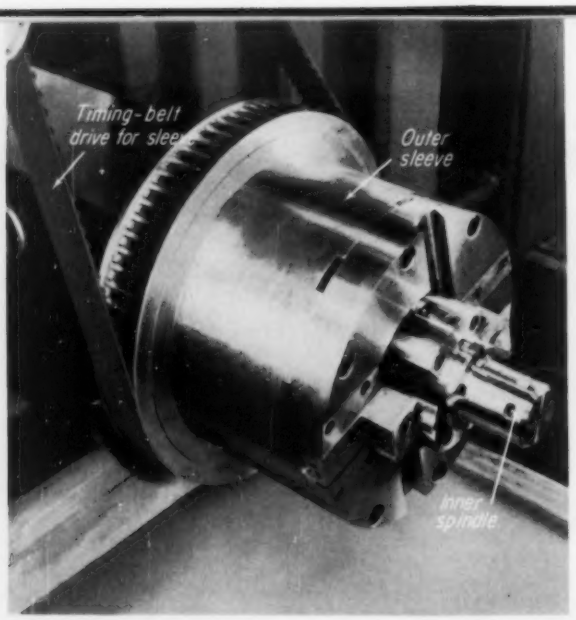


IN NEW PRODUCTS

Representative selection . . .
of available accessories includes tools for farming, forestry, road and powerline maintenance. Besides the items it mounts, the vehicle doubles as a tractor for trailer-mounted equipment.



Rugged chassis . . .
gives a stable platform for the suspension and power train. Steel channels of the chassis side rail are boxed at stress points with welded plates. Heavy crossmembers support engine-transmission units and power take-off shafts. Each wheel has coil spring and double-acting shock absorber, allowing the flexibility of movement necessary for good traction under all conditions. Engine-mounted compressor provides air for front and rear power lifts, body dumping, and trailer brakes.



Sleeve and spindle . . .
operating independently, plunge-face and bore the concentric and eccentric diameters. Outer spindle or sleeve, with two tools, bores and turns two concentric diameters and plunge-faces one pocket surface. The inner spindle, with two tools, bores an arc and bushed hole, eccentric to the other machined surfaces. Jackshaft and timing belt rotate outer sleeve at same speed as inner spindle to prevent tool interference.

Eccentricity for Accuracy

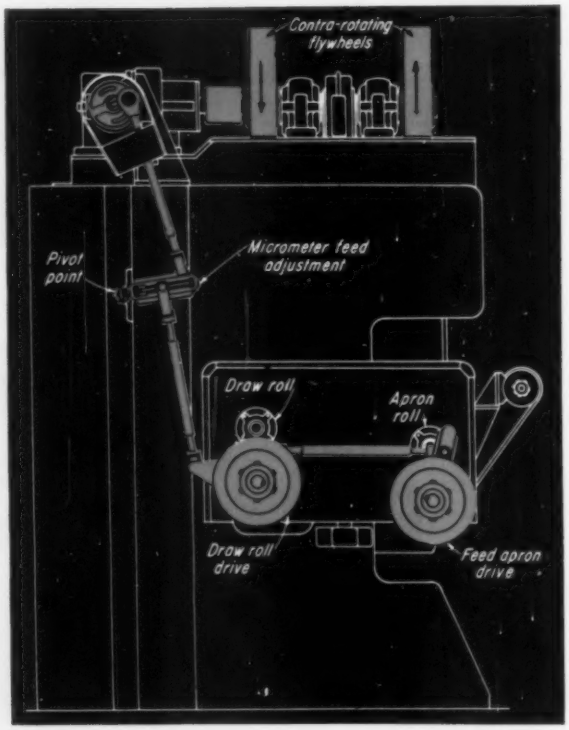
Eccentric spindle and belt-driven sleeve give close-tolerance machining of eccentric sections of cast-iron pump housing. The single setup reduces production time and eliminates alignment problems caused by eccentric bores.

Eccentricity is held to ± 0.0005 in. Pocket faces are held square to diameters to 0.0005 in. Design is by Ex-Cell-O Corp., 1200 Oakman Blvd., Detroit.

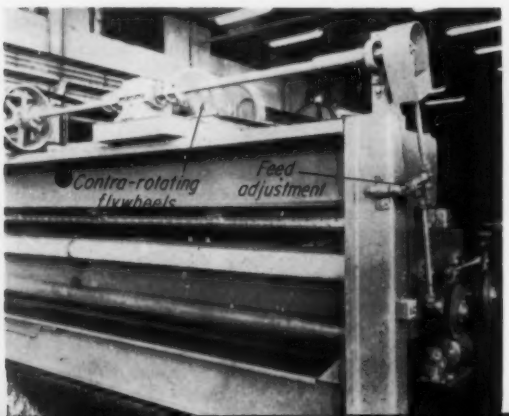
Opposed Flywheels for Smoother Feed

To improve accuracy, vibration and backlash were designed out of the intermittent feed-stroke of this loom—with counter-rotating flywheels and paired overrunning clutches.

Loom was designed by James Hunter Machinery Co., N. Adams, Mass.; clutches by Formsprag, Warren, Mich.



Drive-line surges . . .
resulting from intermittent feed mechanism are absorbed by two sets of contra-rotating, counterweighted flywheels. Four overrunning clutches drive the draw roll and feed apron. One clutch indexes each unit; the second gives positive backstop action. An infinitely variable micrometer adjustment can vary length of feed stroke during operation.



Scale Gages to Hundred-thousandths

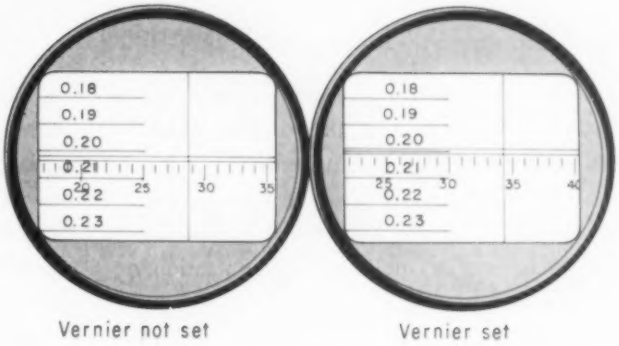
Vertical scale and horizontal vernier are combined in this optical gage to give readings accurate to 10 microinches. Tape suspension and limit switch prevent spindle damage and assure repeatability of readings.

Developed by Bausch and Lomb Optical Co., Rochester 2, N. Y., the DR-25 Optical Gage has a measuring range of 3 inches. Smallest direct reading is 0.0001 in.; experienced operators can readily estimate measurements as small as 0.000025 in.

Two knobs . . .
control entire gaging operation. Left-hand knob operates spring-loaded switch to move measuring spindle electrically. Right-hand knob actuates vernier for scale setting and reading. Friction clutch or vernier control permits it to slip if driven beyond limit stops.

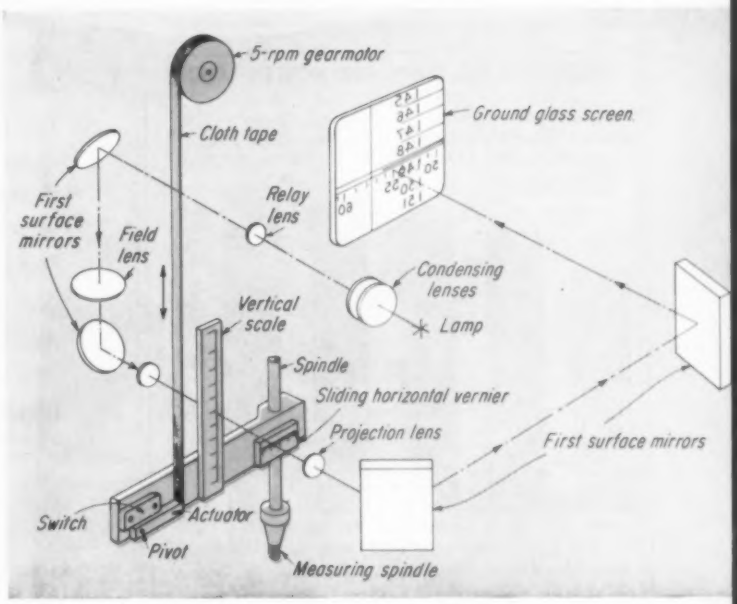
With power on, two scales are visible superimposed on the ground glass screen: a vertical primary scale with horizontal lines graduated in increments of 0.01 in.; and the horizontal vernier—a pair of horizontal parallel lines running across the screen, and a total of 101 short vertical lines, with every fifth line numbered. A single vertical index line also appears in the viewing field. Each graduation of the horizontal scale moves the double parallel lines vertically 0.0001 in.

The measuring spindle is brought into contact with the work by the left-hand knob. The right-hand knob is then used to bracket a horizontal line of the vertical scale. The vernier is read by locating the division nearest the vertical index line.



Vernier not set Vernier set

Horizontal and vertical . . .
scales are superimposed and projected on ground glass by lamp and folded optical system. Gearmotor controlled by left-hand switch-knob lowers measuring spindle. When work is contacted, cloth tape continues to descend; lowering switch actuator. Open switch interrupts circuit, stops motor. Right-hand knob is connected by mechanical linkage to sliding horizontal vernier. Slope of 0.01 in. for the 100 graduations in sliding vernier gives a vertical change of 1/100 of 0.01 or 0.0001 in. per division.

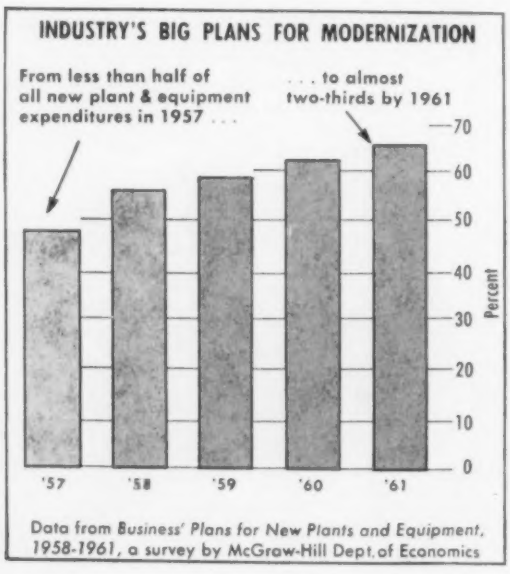


PLAN '59

A MESSAGE TO AMERICAN INDUSTRY

Modernize Now — For Growth and Profits

The biggest challenge facing American industry today is that of thoroughly modernizing its plant and equipment. This is the test period for companies to prepare for success — or failure — in the '60s. Success depends decisively on one key policy — modernization, for growth and profits.



The problem of business recession is fading. Sales and industrial production are moving up again, slowly. Business is swinging back into its normal course. This is growth, not retreat and recession. If the recovery takes us back to the normal growth trend, industrial production will be up 15% to 20% by 1960.

But how can we get this growth in production without the plague of price inflation that has blighted our economy in recent years? And, of fateful consequence for the individual business firm, how can it keep its costs down enough to make a decent profit — something a very large share of American companies are not doing today?

This is the new challenge that confronts business as the recession is left behind.

Nature of the Challenge

The recent record on costs and productivity is not reassuring. Since 1947 wages in manufacturing have risen 68%, while output per manhour has gone up 32%. This is a dismal record for a nation that has prided itself on

gains in industrial efficiency. Clearly, if we are to avoid continuing inflation, labor must key its wage demands more closely to productivity increases. But clearly, also, we must do far better in raising output per manhour. Otherwise, industry cannot hope to offer stable prices, and still make a profit.

What, then, is the answer? It is modernization of plant and equipment, the replacement of obsolete producing facilities with new and more efficient machinery and buildings. Only in this way can industry hope to increase production, hold down costs and make a good profit showing in the years of growth that lie ahead.

Industry's Answer

The chart on the preceding page shows how American industry is buckling down to the task of modernizing its facilities over the next four years. It is planning to replace old equipment with new machines that will raise output per worker not just 2% or 3% a year, but more like the 5% annual gain in productivity that this nation achieved in the years following World War I.

Since World War II we have had to contend with shortages of capacity and materials that have held back the job of raising productivity. But today the machines and techniques are available. And industry is getting set.

A broad sample of manufacturing companies surveyed by the McGraw-Hill Department of Economics earlier this year reported these plans: **In 1958, expenditures for modernization will rise to 56% of total investment in new facilities — compared to 48% in 1957. And this emphasis will increase until by 1961, expenditures for replacement and modernization account for two-thirds of all capital spending by manufacturing companies.** In dollar terms, manufacturers will spend more on modernization in each of the four years 1958-61 than in any previous year except 1957.

Can It Be Done?

These are big plans. Can they be carried out? Is it too visionary to hope that after a decade of expansion, industry can now find the outlets for huge amounts of capital investment in the area of modernization? The answers are important to business and the nation, because on this new wave of modernization depends our hope of holding down costs and prices, and also the prosperity of the vital capital goods industries — generators of boom and bust in our economy.

To ensure that industry gets the answers, McGraw-Hill's 34 business publications are now starting a coordinated effort — the largest editorial effort in the history of our company — to find, report and publish the opportunities for modernization at a profit, in the fields we serve. These special reports will begin in late September and will run through November, with appropriate coverage for the specific needs of each field. We are proud to share with industry the responsibility for making sure that no opportunity is overlooked in the drive to modernize now for growth and profits.

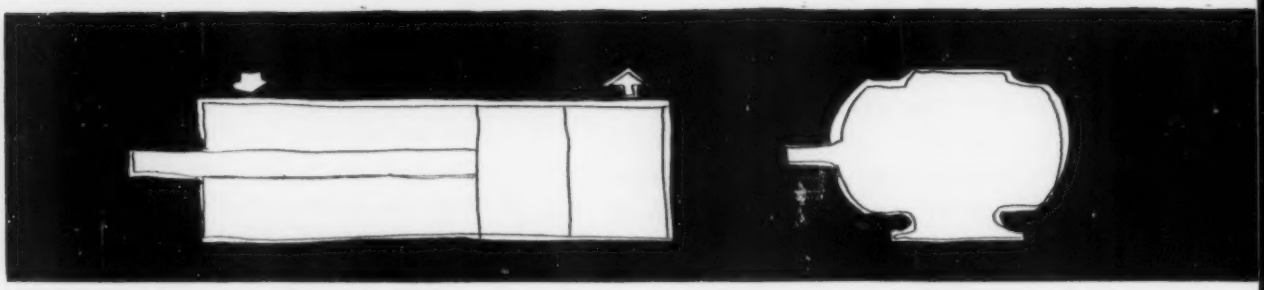
This message was prepared by the McGraw-Hill Department of Economics as the first step in our company-wide effort to report on opportunities for modernization in industry. The Department is also preparing a longer report, on modernization as a national problem, for publication in October.

Permission is freely extended to newspapers, groups or individuals to quote or reprint all parts of the present text.

Donald C McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.



How Fluid Power Compares With Other . . .

MACHINE-TOOL CONTROLS

There is already a large potential demand for machine tools with improved control and actuation . . . and the need will inevitably grow. But the question is: "Which Control?"

FRANKLIN D. YEAPLE, JR., *Associate Editor*

This article is based on a talk by the author at the meeting of NFPA (National Fluid Power Association) in Bedford, Penna., last June 2, 3, 4 (see *PE—June 23, '58 p. 25*).

Some background for the brief talk was obtained from editors of *American Machinist*, and from the McGraw-Hill Research Dept., which contributed recent statistical information. Opinions given are the author's, and are based on informal discussions with users and designers of machine tool controls.

A frequently asked question has been: "How well can hydraulic and pneumatic machine-tool control elements compete with electrical, electronic and mechanical?" The answer is "Very well," but the ground rules are strict.

Preference by the user sets the pattern of selection. Inherent advantages of each power and control medium (oil, air, cams, etc.) cannot be overlooked for long, nor should combinations be ignored. The answer for component manufacturers is to understand the technical reasons for using one system over another, then give encouragement in the right places. The most prejudiced builder or buyer will eventually recognize economic advantages, throw out his pet relics, and go modern.

HYDRAULIC VS ELECTRICAL

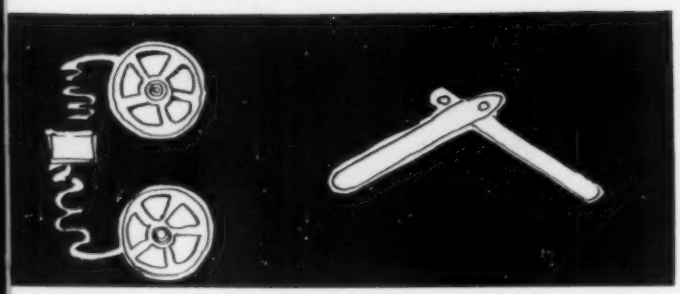
Hydraulics makes possible a moderately positive or "stiff" system, particularly for short movements, in minimum space. Jig borers need such qualities. Also, a high-pressure cylinder is usually smaller than equivalent motor-lead-screw combination for an adjustable boring tool. Pressbrakes, usually thought of as mechanical, are now successfully made with two compact hydraulic cylinders perfectly balanced for pressure and travel by a servo system. A hydraulic motor turning a lead screw usually has less inertia and greater torque than an equivalent electric motor; is therefore faster. Templet followers can use simple hydraulic tracers to operate hydraulic actuators.

Electrohydraulic (and pneumatic-hydraulic) systems combine power advantages of hydraulics with speed of remote-controlled servos. Many companies are already marketing electrohydraulic servovalves. These valves let most high-speed signalling equipment be remote from the machine . . . low energy is involved and small transmission lines can be used. The power elements (final valves, etc.) are on the machine.

Electronic tape control is already replacing templets of some hydraulically powered contour-machining equipment. Instead of templet and hydraulic tracer, an electric-to-hydraulic transducer receives signals from punched tape with same end result. Some of these follow as many as five simultaneous axes. A limitation here is the difficulty in achieving "feedback" to the tape for checking purposes. Hydraulics is in different units than electronics or electrical, requiring numerous transducers. Electrical actuators are more adaptable than hydraulic where complex contouring with continuous feedback to tape is essential.

Problems in hydraulics are compressibility (for long strokes), leakage, fire, generated heat, seals, temperature, and maintenance.

Leakproof seals are offered, but installation and



maintenance are never quite as good as hoped. One major engine manufacturer a few years ago determined that the average amount of hydraulic fluid consumed by all the factory machine tools and equipment was about 6 gal. per delivered engine. Pressure levels were purposely kept low (250 psig) for leakage and other reasons.

Fire-resistant fluids are available, but choice of component materials is still very critical. Water, petroleum, synthetics, combinations . . . each affects packing and metals differently and a real education job is still required.

Heat generation can be reduced by better valve and pump efficiencies. Improved component materials for high temperatures are being developed. Many problems of fluid flow are being licked by manifolding. For example, lines can be shorter, joints eliminated. Some companies are casting machine structural parts around pre-positioned tubing . . . this gives permanently leakproof service, plus cleaner appearance.

PNEUMATICS FOR ASSEMBLY AND TRANSFER

Air can be easily stored for quick release, and is ideal for assembly operations. Good applications are: feeding parts, riveting, clamping, tightening screws, inserting retainers, and tapping threads. For transfer operations from one machine to the next, compressed air can be applied instantly.

Air is preferred where fire hazards exist, oil leakage is not allowed, or nuclear radiation is a problem. Aircraft can use high-pressure air (3000 to 5000 psig, maybe higher) and may conceivably set the trend for high-pressure pneumatics.

Pneumatics is adaptable to so-called logic circuitry (AND, OR, NOT, MEMORY and TIME DELAY), and can be compared with electrical switches, relays and tubes. The same air can be used to clean parts, atomize fluids, and cool hot spots.

Limitations are size, extreme compressibility, time lag, and poor repeatability. Pneumatics does not serve well for precise positioning. Also, air is expensive to compress, particularly if it is eventually exhausted to atmosphere.

MECHANICAL GIVES BACKBONE

There are no parts more positive than well-built mechanical elements, such as cams, gears, and levers. The mechanisms are easier to understand, maintenance people are used to them, and there are relatively fewer problems. It is reported that some machine-tool builders have gone the cycle from mechanical to hydraulic to electronic and back to mechanical. Actually, every machine tool and control has some mechanical elements; many have fluid and electrical parts as well. As long as tool bits must cut metal, mechanical parts are going to remain.

AUTOMATIC OPERATION

Automatic operation, particularly tape-controlled, is becoming more of a necessity because of growing shortage of trained and dedicated machinists and operators. They are often tempted by ever increasing opportunities to switch to the more colorful "service" end of the business. Recent statistics indicate about a 60/40 ratio between persons engaged in selling and servicing equipment, and those manufacturing it. Therefore, management is forced to plan for automatic or semi-automatic production.

More engineers are being hired for design of automatic control systems. Small job shops cannot support this help, but are able to contract with companies such as General Electric or Westinghouse for engineered systems to be put into existing or contemplated machines. Machine-tool builders of very-high-production automatic machines can afford to engineer larger portions of the controls themselves. Wherever the engineering is done, there is where trends are started and components selected. And it will be wise to understand why they do the things they do.

EDITOR'S NOTE: Over five dozen articles in the past few years have covered controls and actuators. Only a representative list can be given here.

New machine tools made possible by design improvements in control and actuation were announced in: "5 Hydraulic Circuits for 3-Job Machine," June 23 '58, p 76, shows how combination of cylinders, hydraulic motors, electric motors, lead screws, and gears give versatility to special multipurpose machine tool; "Wide-range Spindle Drive," Mar 31 '58, p 113, describes infinitely-variable electronic speed control using dc motor integral with spindle; "Linkage Adjusts Table Tilt About Two Axes," Feb 3 '58, p 64, demonstrates how automatic mechanical linkages are synchronized to keep table surface flat at all compound table angles; "Electronic Tracing Systems Control Milling Machines," July '57, p 150, describes electronic tracer that follows a templet and uses feedback for machining workpiece; "Electrohydraulics in Machine Tools," Jan '56, p 188 and Dec '55, p 129, shows how one manufacturer uses electrohydraulics extensively in design of milling machines, planer-millers and lathes.

Fluid-operated components are discussed in detail in: "Maintenance Advice for Fluid Circuits," Mar 17 '58, p 71, helps prevent faulty installation and careless use of hydraulic controls; "Fire-safe Hydraulic Fluids," Nov '56, p 194, analyzes aqueous- or phosphate-base fluids in terms of effect on packings, paint, etc.; "When Pistons Need Brakes," Feb 3 '58, p 56, gives design ideas in applying cylinders for fast movement; "Compressed Air for Push or Pull," Oct 14 '57, p 72, shows many ways to actuate with air; "Memory Valv for Logic Circuits," May 26 '58, p 76, describes valves helpful in assembly or transfer sequencing; "Hydraulic Control Valves," in 5 parts, the last appearing Jan '57, p 196, describes in detail every type of fluid valve.

Coming in Sept 1 an article on "Numerical Control" showing how punched tape and cards eliminate templets.

FOR REFINING METALS . . .

There's nothing better than VACUUM

By turning out purer and stronger castings, it leads to more reliable parts. But the vacuum-refining processes differ widely in what they can do—author includes a ready-reference chart.

L. W. JOHNSON
Industrial Heating Dept., General Electric Co.

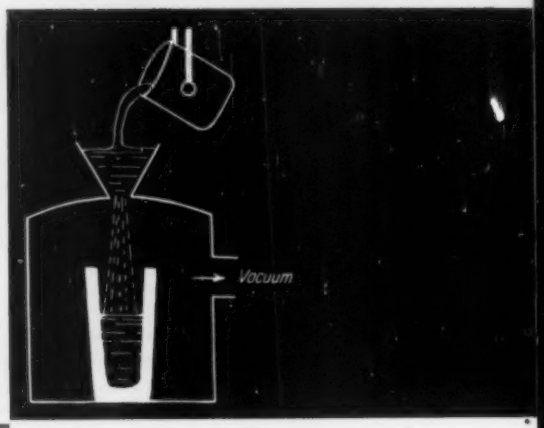
Although patented as far back as 1883, vacuum refining was considered impractical even up to 10 years ago. Now it has grown to wide industrial use by more than 40 major companies. It sprouted as a development of the titanium and molybdenum industries but, like so many infants, soon outgrew its parents and struck out for jobs of its own. Vacuum units, larger and more efficient than ever before, now cast bigger and more consistent steel for forgings, stronger superalloys, and such exotic metals as hafnium, rhenium and tantalum. The last three owe their ductility, and therefore engineering usefulness, to the high purity given by vacuum melting.

Better properties of the vacuum-melted metals come from over-all cleanliness of the technique, a metal sounder because of less segregation, and possibility of adding alloys that air melting will not allow. Results include higher values for creep and rupture strengths, impact and fatigue strength, transverse strength and ductility, and better magnetic and electrical properties. But application possibilities vary because vacuum refining processes aren't all the same.

One may consist of a short pass through a vacuum for degassing. Another requires prolonged melting and refining. Some handle hundreds of tons; others, only several pounds. Each type of metal must be treated its own way and each process is intended for its own end-products. Some processes boost costs by 10 or 20 times; others increase it only a small percentage, and even lead to a cheaper end-product. What these processes are, their salient features, and what they can do are compared in the accompanying chart.

The processes vary in equipment and in technique of melting, purifying, and casting—combinations that give specific quality and have their own advantages and disadvantages. No vacuum process is universal.

CHARACTERISTICS OF



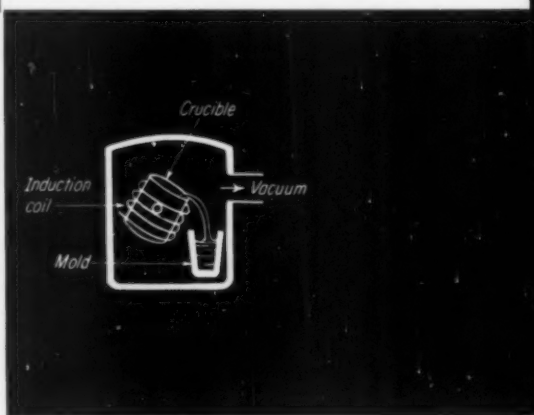
Vacuum-stream Degassing

Low-alloy steel ingots for large, critically stressed forgings

5000 lb to 250 tons

Relatively low investment for large capacity

Strictly degassing, little or no other purifying



Nonconsumable Electrode —Cold Mold

Ingots of reactive metals

Ounces to several pounds

Wide range of feed sizes and shapes

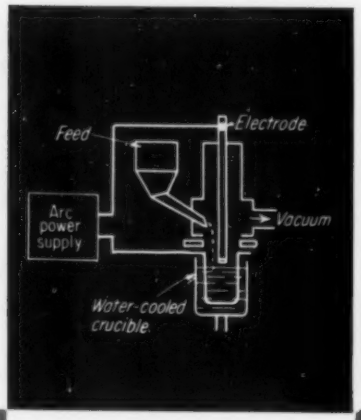
Controlled melting rate

Contamination from electrode

DEGASSING ONLY

Vacuum will remove dissolved gases and volatile impurities when molten metal enters a vacuum chamber.

VACUUM-REFINING METHODS AND THEIR METAL PRODUCTS



Vacuum Induction Melting

High-strength iron and nickel-base alloys

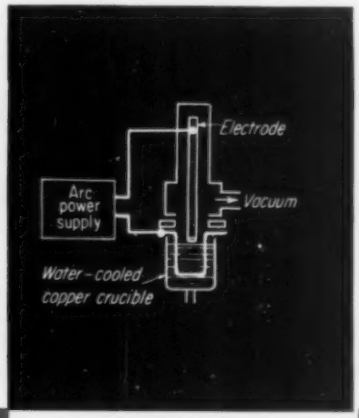
Capacity limit—1 to 5000 lb

Variable melting rate and degassing time

Wide range of feed sizes and shapes

Can pour shaped castings

Contamination cannot be avoided



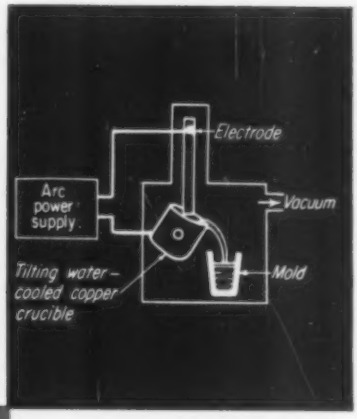
Consumable Electrode —Cold Mold

Ingots of any metal

1 to 25,000 lb; larger capacity possible

Gives purest and most homogeneous metal

Some metals difficult to form into electrodes



Consumable Electrode —Cold Crucible

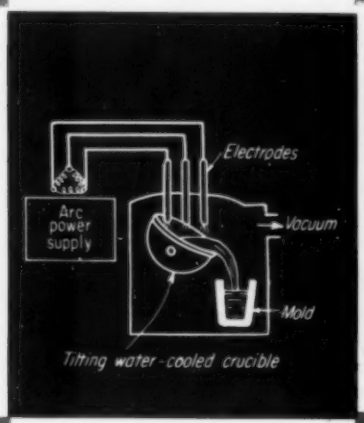
Shaped castings include highly reactive metals

1 lb to 100 lb

Can only melt and cast metals already purified, degassed, and alloyed

Large skulls must be stored

Mold materials not entirely satisfactory



Nonconsumable Electrode —Cold Crucible (Skull)

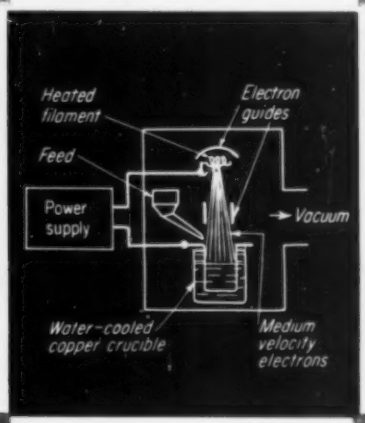
Ingots or castings of reactive metals

500 lb to 20 tons

High-capacity continuous operation

Can melt wide range of sizes and shapes, including scrap

Capacity too large for present demand



Electron Bombardment

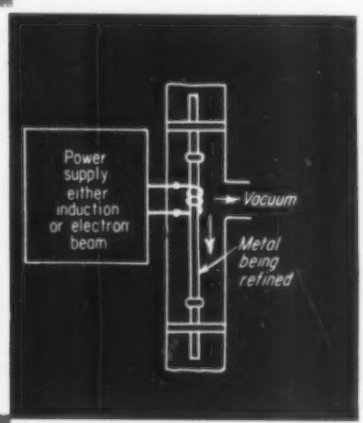
Small ingots of any metal

Max ingot size about 10 lb

Can melt fine powders

Can melt at very low pressures, 1/10 micron or lower

Equipment expensive, low capacity



Zone Refining

Metal rods only

Max quantity, several lb

Extreme purity

Limited to unalloyed metals

Low capacity

In this process the chamber also contains the mold. The emerging gases break the stream into a fine spray—this speeds the process. Such degassing eliminates the main roadblock to practical vacuum treatment—the metal can be melted by conventional in-atmosphere methods. Ingots up to 250 tons have been produced (*PE*—May 26, p 70). This technique only degasses, does not otherwise purify or refine the metal, but it is economical and sucks out enough of the harmful gases to give large forgings free from flakes.

DEGASSING PLUS REFINING

In these processes vacuum melting refines the metal completely before casting. It removes all gases, but

WHERE TO GET VACUUM METALS

The field is growing so rapidly that no list can be complete. But here PRODUCT ENGINEERING has assembled an up-to-the-minute directory of producers.

Induction-melted:

Allegheny Ludlum Steel Corp.; Allvac Metals Co.; General Electric Co., Metallurgical Products Dept.; Haynes Stellite Co.; Universal Cyclops Steel Corp.; Utica Drop Forge and Tool Div.; Crucbile Steel Co.; Vanadium-Alloys Steel Co.; Cannon-Muskegon Corp.; Wah Chang Corp.; Fansteel Metallurgical Corp.; International Nickel Co.; Wilbur B. Driver Co.; Austenal, Inc.; Kolcast Industries, Inc., Titanium Metals Corp.

Arc-melted:

Allegheny Ludlum Steel Corp.; Electro Metallurgical Co.; Haynes Stellite Co.; Universal Cyclops Steel Corp.; Crucible Steel Co.; Vandium-Alloys Steel Co.; Timken Roller Bearing Co.; Carpenter Steel Co.; Mallory Sharon Metals Co.; Republic Steel Corp.; US Steel Corp.; Oregon Metallurgical Co.; Firth Sterling Steel Co.; Harvey Aluminum Corp.; Olin Mathieson Chemical Corp.; Babcock and Wilcox Co.; Midvale Heppenstall Steel Co.; Carborundum Metals Co.; Fansteel Metallurgical Corp.; Climax Molybdenum Co.; Johnston & Funk Titanium Corp.; Vaculloy Corp.

Stream-degassed steel ingots:

Bethlehem Steel Co., and US Steel Corp. (Standard Steel Works Div. of Baldwin-Lima-Hamilton Corp. expects to be in operation by fall.)

Almost all large manufacturers of transistors do their own zone refining. For a list of such manufacturers see "Transistors vs Tubes for Industrial Applications," Oct. 28, '57, p. 52.

---

all the melting and casting equipment must be enclosed in vacuum. This means cheaper methods of combustion heating with oil and gas cannot be used, and size of casting is therefore economically limited. Also, analysis of alloy content cannot be done in the chamber: standard steps are to vacuum-melt, solidify, remove from vacuum, check analysis, and then remelt. This is expensive. The processes are:

Induction heating can melt different sizes and shapes of material, give close control of melting rate and degassing time, and allow casting finished shapes. But induction heats the crucible to the same temperature as the metal, which then picks up contamination. Induction is most effective for iron and nickel base alloys because alloying agents, even reactive ones, can be added if timed to the later stages of the melt.

Electron bombardment will melt material in rod, in odd shapes, and in fine-powder form. When a beam of accelerated electrons is focused at a metal, it heats and melts it. In a standard setup, two electron beams are used: one to melt metal from the end of a rod; and, as the melt drips into a crucible, a second beam to keep the pool molten. The beams can melt metal at pressures of 0.1 microns or lower. At present, high initial cost and low capacity limit the method to melting small quantities of special metals.

Electric arc melting, whether with inert or consumable electrodes, is efficient and its intense heat can handle metals with the higher melting points.

1. Inert electrodes made of high-melting-point materials like tungsten or graphite form an arc with the metal, causing it to melt. The method allows feeding metal into the molten pool at a controlled rate. But there is no truly inert electrode material, so, in many cases, contamination from the electrode material is sufficient to eliminate this process.

2. Consumable electrodes are rods made from the metal that is to be melted. The rod and pool of metal below it form the electric circuit. The arc melts rod metal which falls into the pool. This eliminates contamination from so-called inert electrodes, but adds the step of making consumable ones.

MOLDS AND CRUCIBLES

The molten metal is then vacuum-cast. While molds are no different in shape than for other casting methods, they must be free from moisture and volatiles which give expanded vapors at the low pressures. Metal molds are preferred because non-metal ones may still retain volatiles even after baking.

Cold molds, most often used, are made of copper and water-cooled. Molten metal solidifies progressively upward around the edge of the mold; in a continuous process the metal ingot may be drawn slowly from the bottom. Soluble impurities remain in the molten pool that moves upward into the head of the ingot. This is later cropped off and discarded. Impurities not preferentially soluble solidify with the metal and so are distributed uniformly throughout.

A crucible chilled by water, like a cold mold, is made of copper. The initial melt freezes and provides its own lining, insulating remainder of the pool from contamination. The non-contamination is specific; each metal lining can be reused only for the same alloy, and the large skulls or linings must be stored until the same alloy is melted again.

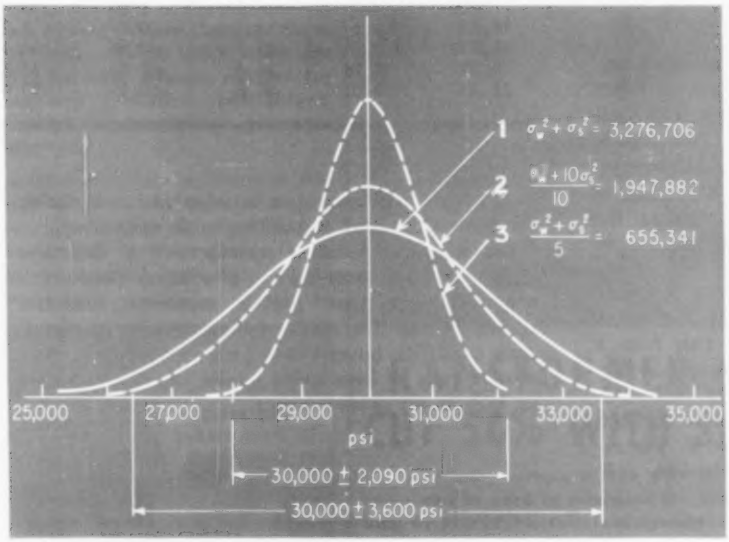
FOR HIGHEST PURITY

Zone refining is the final purifying step for metals that have already been vacuum-refined. The heat, supplied by induction or electron beam, is moved upward along the length of a rod. Progressive melting and progressive dissolving of impurities is repeated until the metal becomes pure enough for its end use—usually semiconductors. But alloying metals have preferential solubility, too, and are also eliminated with other impurities. Obviously this refining method can only handle unalloyed metals. Though expensive, it remains our only practical way to make transistor materials.

PLAN '59—modernize now

This will be the theme for the first two issues in October. Surveys and special staff articles will tell "Why" in October 6 and "How" in October 13, both written for the average-size engineering department.

STATISTICS BUILD precision and economy into . . . MATERIAL SPECIFICATIONS



Testing Plans Compared . . .
for a hardboard specification set at 30,000-psi flexural strength. Broad-based curve (1)—random sampling of variability; (2)—random sampling of one sheet, 10 tests per sheet; (3)—random sampling of 5 sheets, one test per sheet, gives maximum information per test for the same cost as (2).

Three-step procedure outlined by the authors also helps producer and user to get together in reducing risk of rejects.

H. R. SHEPPARD and H. GINSBURG
Materials Engineering Dept.
Westinghouse Electric Co.

Statistics can fool you—they seem a tediously expensive way to set up specifications for materials. But because they are more exact than established methods, they save money in the long run. Their accuracy minimizes three expensive factors—rejection of satisfactory lots by the consumer, low-quality materials that give defective products; unnecessarily high-quality materials that mean higher costs and therefore a poor competitive position.

Applying statistical methods in drawing up a specification involves three steps:

- Determining the characteristics for both satisfactory and unsatisfactory material
- Picking the best sampling plan
- Setting up the specification.

The first step is based on the familiarity every engineer has with his material. Shop or lab tests will tell the user of material what properties he requires to do the job. Let's say the material is hard fiberboard, in sheets, and that extensive tests show that a satisfactory batch averaged 30,000-psi flexural strength. This is recorded. Then the user tests lower-quality lots to find an unsatisfactory batch. Suppose it averages 25,000 psi flexural. This data is recorded too. Armed with both averages, the user now decides on a bulk-testing procedure.

THE SAMPLING PLAN

Both testing cost and effectiveness go into the choice of sampling plan. A good plan must either: minimize testing cost for a fixed degree of precision or maximize precision for a given cost.

Suitability of the plan depends on a pair of measurements—the variability between specimens on the same sheet, and the sheet-to-sheet variability. Suppose each specimen costs A dollars to prepare and test; going into a new sheet costs B dollars. Then cost of testing 10 specimens from a single sheet is $10A + B$ dollars. But this may be a poor test. It reflects only the variability among specimens on the same sheet.

Since a specification lists the properties of a material and acceptable limits of variability, the user must know

with what certainty he accepts or rejects a good or bad lot. So his specs must list the desired average, or mean value, $\overline{Y}$, of the lot; and the variability from the mean, which can be expressed statistically in terms of the standard error of the mean. This error measures dispersion of sample averages about the mean: the lower the standard error, the more closely the test results are grouped about the batch average, and the more precise the test procedure.

The standard error is found by taking the square root of the variance of the mean, $V(\overline{Y})$, determined from the test results by the equation

$$V(\overline{Y}) = \frac{\sigma_w^2 + w\sigma_s^2}{sw}$$

where σ_s^2 represents the sheet-to-sheet variability, σ_w^2 the variability within a sheet, s the number of sheets sampled, and w the number of specimens from each sheet. In the curves shown on page 75, each reflects information about the batch from a different sampling plan. Area under the curve represents total number of lots; flexural strengths are plotted on the abscissa; the ordinate represents statistical estimate of number of sample averages of that strength.

Each cost-testing situation determines the best sampling plan. Two of the plans covered by the curves illustrate this. Curve (2), based on 10 tests from a single sheet of hardboard, result in a variance of the mean—the criterion for precision—of 1,947,882. But the cost of this precision depends on relation between specimen-test cost A and sheet-cutting cost B. For example, if A = B, cost of sampling would be 10A + B = 11A.

Compare this with fewer tests from more sheets—the best method to increase reliability at no greater testing cost. Curve (3) illustrates one test from each of five sheets. User's cost is 10A, and the calculated variance is 655,341. Thus the user gets greater precision for no greater cost (actually 10% less).

Suppose A and B are vastly different. For example, if the cost of cutting into a new sheet was higher—say, four times the cost of a single test (B = 4A), then 10 specimens from a single sheet will cost 4A plus 10A, or 14A dollars, and the variance of the mean would be 1,947,882. But two random specimens from each of two sheets would cost only 8A plus 4A, or 12A dollars, and the variance of the mean would be 1,269,235. Here again, fewer tests—carefully chosen—yield more accuracy at no greater cost.

SETTING THE SPECIFICATION

After setting up the sampling plan, the user is ready to specify the average value to demand—and the limits of variability to accept. The specifications can be set high enough to avoid any significant risk of accepting low-quality material, but . . . as he decreases this risk, he increases the risk of rejecting satisfactory material—and this will eventually cost money.

Here the user has to consider the significance of materials costs. If he is a large-volume materials consumer—say, a maker of refrigerators, fans, air conditioners—materials cost per unit is relatively high, and cost-cutting is relatively important. He may be willing to risk some replacement or maintenance costs during the guarantee period to keep materials costs down.

On the other hand, a manufacturer of expensive custom-built apparatus such as generators, transformers and switch-gear must provide maximum insurance against failure. He needs—and must pay for—maximum reliability, because each piece of equipment must provide years of dependable service. Specifications are set high to get needed quality.

SAMPLING PLAN SETS RISK

Flexural Strength, psi (Min. Avg.)	10 Specimens From 1 Sheet		1 Specimen From Each of 5 Sheets	
	Producer's Risk, %	Consumer's Risk, %	Producer's Risk, %	Consumer's Risk, %
30,000	50.0	0.02	50.0	<0.01
29,500	36.8	0.06	26.8	<0.01
29,000	23.7	0.2	10.8	<0.01
28,500	14.1	0.6	3.2	<0.01
28,000	7.6	2.0	0.7	0.01
27,500	3.7	3.7	0.1	0.1
27,000	2.0	7.6	0.01	0.7
26,500	0.6	14.1	<0.01	3.2
26,000	0.2	23.7	<0.01	10.8
25,500	0.06	36.8	<0.01	26.8
25,000	0.02	50.0	<0.01	50.0

HOW MUCH RISK

Chances of getting quality can be expressed statistically. From standard error-of-the-mean data, two test plans can be compared, as in the table on this page. One shows that setting the minimum average value at 26,500 psi and testing 10 specimens from a single sheet will guarantee 85.9% satisfactory lots. In other words, the user's risk is 14.1%, but the producer's risk—chance that his satisfactory lots will be rejected—is only 0.6%.

Note however, if a higher minimum average value of 28,500 psi is set, the situation will be reversed: Approximately 14.1% of the truly satisfactory lots will be rejected (producer's risk) and only 0.6% of the lots accepted will be unsatisfactory (user's risk). If both producer and user can agree to share risks equally, a minimum average value of 27,500 psi puts the risk to both at 3.7%.

By modifying the sampling plan, both risks can be decreased, with less possibility of a substandard lot slipping through, or fewer rejections of truly satisfactory materials. For example, one specimen from each of five sheets taken at random will permit the user to set the average mean value at 28,000 psi, and cut his risk to 0.01%. At the same time, producer's risk is cut to 0.7%. A modest compromise, to 27,500 psi, equalizes risks at 0.1%.

From this simple example, the two main advantages of statistically prepared specifications emerge: maximum precision can be obtained for a given testing cost; specifications are established that are fair to both producer and consumer, and their respective risks can be evaluated.

first in silicones

Dow Corning

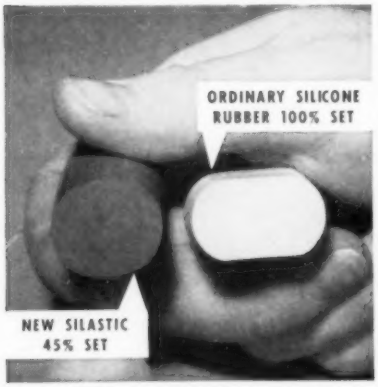
SILICONE NEWS

for design and development engineers • No. 53

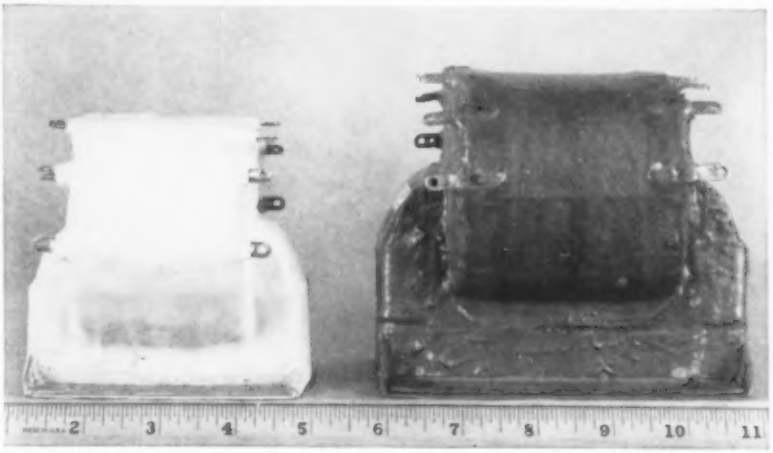
NEW SILICONE RUBBERS RESIST COMPRESSION SET

Three Silastic® compounds with greatly improved resistance to compression set are now offered by Dow Corning. Serviceable from —70 to 500 F, they are superior to other silicone rubbers for sealing and gasketing, particularly where high or continuous pressures are involved.

The accompanying photo illustrates that one of these new Silastic stocks, after aging 22 hours at 480 F, exhibits only 45% compression set while ordinary silicone rubber (white) is deformed 100% under identical conditions.



As a result, the new Silastic stocks are recommended for many automotive, appliance, aircraft, industrial and military applications. In addition, they are expected to prove superior for O-rings and *(Cont. Pg. 2)*



TRANSFORMER SIZE AND WEIGHT CUT 50% WITH SILICONE DIELECTRICS

An excellent example of the way silicones can be used to minimize the size and weight of electrical equipment is the 600 VA Aircraft Transformer designed by Air Arm Division of Westinghouse Electric Corporation.

Air Arm Division was able to reduce by approximately 50% both the size and weight of this miniature power transformer for airborne electronic equipment by switching to heat stable Dow Corning silicone dielectrics. Actually 4 lb., 8 oz. were slashed from the original 8 lb., 14 oz. transformer without sacrificing either its rating or capacity.

Just how important is this weight saving? Westinghouse engineers estimate it cuts $3400 from the total cost of every aircraft! Here's how: each pound of equipment requires 14 additional pounds of aircraft and fuel. If the given cost of aircraft is $51 per pound, every initial pound eliminated saves $765. Every pound sliced from the transformer is worth more than its weight in gold.

Another unusual feature: this Westinghouse transformer is encapsulated in Silastic®, the Dow Corning silicone rubber, and then impregnated with a new Dow Corning solventless silicone resin. It's one of the first commercial applications of this solvent-free resin.

Assembled and wound with silicone materials, the transformer is fitted with Teflon filling plugs on each open face, then dipped in Silastic. After the unit has been dipped and cured twice, plugs are removed and the entire unit is vacuum impregnated with solventless silicone resin and given a partial cure. A third and final dip in Silastic followed by curing, completes the encapsulation.

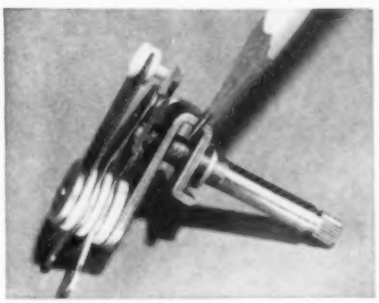
Note that the resin is completely enclosed by Silastic during its cure. *(Cont. Pg. 2)*

Oven Thermostat Lubricated for "Life" With Silicones

Even a minute quantity of silicone fluid can substantially improve product performance. Bimet Electrical Research Corp., Morris, Ill., provides rather dramatic proof of this fact.

Bimet estimates that *just one* gallon of Dow Corning 710G Fluid is all that's required to provide permanent lubrication for 2 *million* of their Belcor thermostats.

Applied to the threads of the calibrated adjusting screw, the silicone fluid lasts 10 times longer, performs better than conventional lubricants. The petroleum oils, used originally, permitted the screws to seize after only 5,000 to 10,000 cycles. They frequently smoked and produced noticeable odors. On the other hand, a drop or two



of silicone lubricant keeps these screws from seizing even after 50,000 cycles . . . and there is no tendency to smoke or give off odor even at oven temperatures as high as 600 F. *No. 538*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE

MORE

NEW ADHESIVE FILM INTERLEAVED WITH SILICONE COATED PAPER

Not a tape because it has no backing, "Tackmaster" is a solid, four-mil sheet of pressure sensitive adhesive that will stick to almost anything . . . on both sides! The problem of packaging this unique adhesive for easy handling was neatly solved by interleaving the film between sheets of paper coated with Dow Corning Silicones.

A polyvinyl ether composition, the new two-sided adhesive is ideal for bonding sheets of almost any material to any other surface. It has a particular affinity for plastics and adheres readily even to Teflon. Silicone coated paper, however, is not affected by Tackmaster's adhesive power.

According to the manufacturer, Rubber and Asbestos Corporation, Bloomfield, New Jersey, it takes only a 3 to 6 ounce pull per inch to strip silicone coated paper from the film. Two to three times this amount of pull is needed to strip off protective backing materials of organic treated papers, waxed glassine or polyethylene film while untreated paper requires 40 to 80 ounces. *No. 539*

TRANSFORMERS *(Continued)*

Free of all solvents, it forms a void-free, uniform mass without bubbling thru the silicone rubber jacket.

Tests indicate the silicone-insulated transformers will withstand severe salt spray, moisture and thermal shock. They show little change in dielectric or mechanical properties after 1000 hours exposure to 250 C hot spot temperatures. *No. 540*

SILASTIC *(Continued)*

other parts in processing equipment for the food, drug and cosmetic industries.

Identified as Silastic S-2096U, S-2097U and S-2098U, the new silicone rubbers produce 60, 70 and 80 durometer (Shore A hardness scale) respectively. All three rubbers achieve maximum resistance to compression set when vulcanized with Silastic S-2084 Catalyst. *No. 541*

new literature and technical data on silicones

Rubber from Rock reveals a number of ways you can use silicone rubber to improve performance and design of mechanical and electrical equipment. It's a full color sound movie that explains how Silastic, the Dow Corning silicone rubber, is made from quartzite. It demonstrates how parts fabricated from Silastic retain rubberlike properties from —130 to 500 F, in automotive, aircraft, and industrial applications. *No. 542*

Pressure sensitive silicone tapes stick to anything, through hot or cold; are water repellent; have high dielectric strength; and are not affected by corrosive chemicals. A folder is available to help you choose the tape best suited to your application. *No. 543*

You can use Dow Corning silicone fluids to advantage in so many different applications, we've compiled and tabulated, in a single data folder, the properties that make them so practical. You'll want to review this concise informative folder and consider how you can profit from their unusual combination of properties. *No. 544*

Ways to cut costs, simplify designs, improve performance, and add new sales appeal to your products are suggestions you'll glean from the 1958 Guide to Dow Corning Silicones. It's 16 pages of data, illustrations, properties and uses are cross indexed for handy reference. *No. 545*

Effective lubrication over the extreme temperature range of —100 to 350 F is provided by Dow Corning 33 Grease, a versatile silicone lubricant described in a new folder. *No. 546*

Selection Guide to Silicone Insulation Components, a new illustrated six-page, two color brochure, details the insulating components used in motors, transformers and generators. Design considerations guiding components selection are pointed out. *No. 547*

Specify SYLKYD® Enameled Wire, a new four page brochure gives data on magnet wire coated with heat-stable film insulation. Points out why this wire aids miniaturization, increases power-to-weight ratio of solenoids, motors, servos, transformers and similar equipment. *No. 548*

Dow Corning Corporation, Dept. 860, Midland, Michigan

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SILICONE NEWS published for design and development engineers

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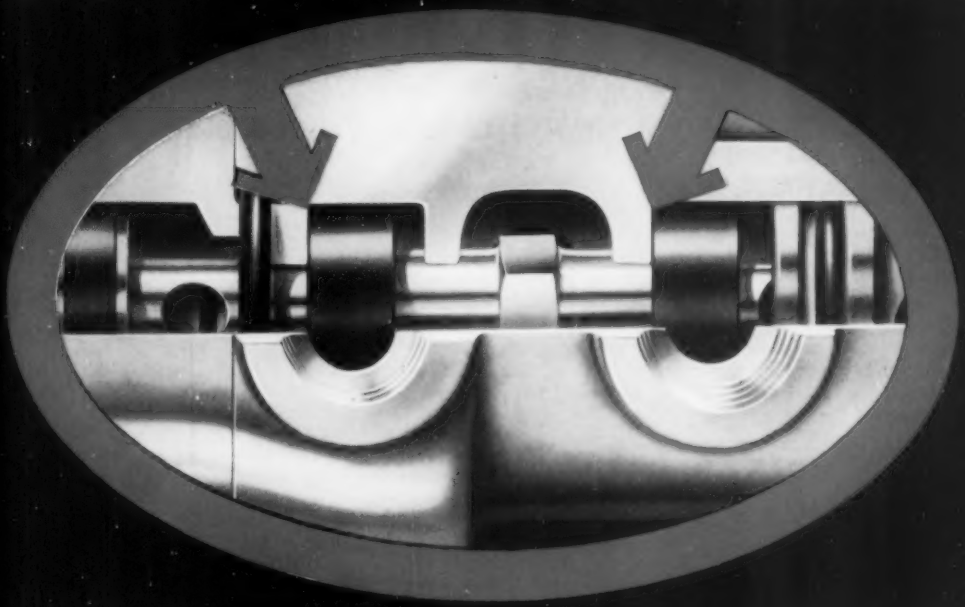
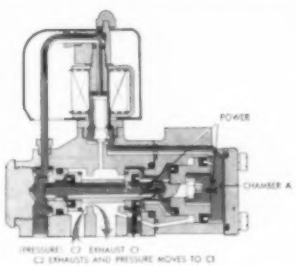
ABSOLUTELY TIGHT SEATING!



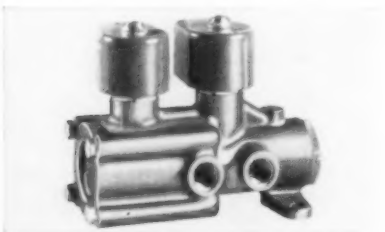
WITH ASCO POPPET TYPE 4-WAY SOLENOID VALVES

Dead tight shut-off—even on air—is assured in these four-way valves through poppet seals, and by a unique combination of metal to metal and resilient seating. No lapping, grinding or close adjustments are necessary — no binding or leaking can occur. Short piston disc assembly travel, basic design simplicity eliminate maintenance problems.

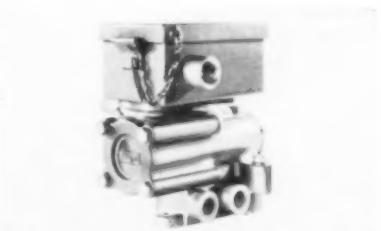
ASCO 4-way Valves are available in ⅜" through 1" sizes, in standard, explosion-proof or water tight enclosures. They can be mounted in any position, and permit cycling rates to 850 per minute.



Operation: ASCO Single Solenoid 4-way Valves are power-driven in both directions by line pressure. When the solenoid is de-energized, line pressure applied to the top of the piston core forces it off the seat, eliminating possible sticking due to residual magnetism. Line pressure is applied to Chamber A, moving the piston-disc assembly to the left. When the solenoid is energized, Chamber A is exhausted and line pressure drives the piston to the right. Single solenoid type (illustrated) operates when solenoid is energized; returns automatically when de-energized.



Dual Solenoid (Bulletin 8344): operates when either solenoid is energized; will not return until opposite solenoid is energized (single solenoid types return when de-energized). In dual solenoid valves, solenoids may be energized continuously or momentarily.



J.I.C. Construction (Bulletin 8346) ASCO Single and Dual Solenoid Valves can be furnished to Joint Industry Conference requirements—valves are provided with subplates, vapor-proof solenoid enclosures, and manual overrides, and are electrically inoperative with the cover removed.

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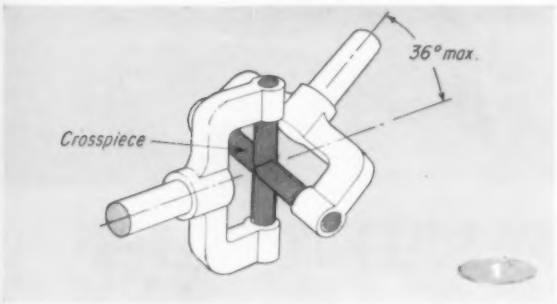
10 UNIVERSAL

FEDERICO STRASSER,
Mankowitz and Strasser, Ltd., Santiago, Chile

The coupling methods illustrated here follow 13

HOOKE'S JOINTS

The commonest form of a universal coupling is Hooke's joint. This can transmit torque efficiently up to a maximum shaft-alignment angle of about 36°. At slow speeds, on hand-operated mechanisms, the permissible angle can reach 45°. Simplest arrangement for a Hooke's joint is two forked shaft-ends coupled by a cross-shaped piece. There are many variations and a few of them are included here.



1

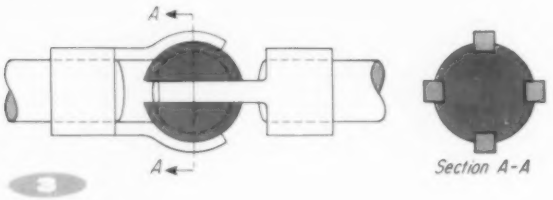
Basic design . . .

of Hooke's joint can transmit heavy loads. Anti-friction bearings are a refinement often used.

2

Pinned sphere . . .

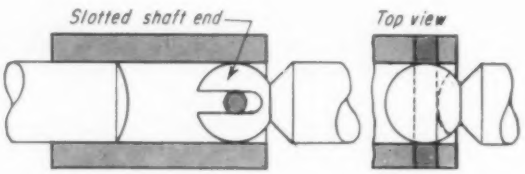
replaces crosspiece in this design. Result is a more compact joint.



3

Grooved sphere . . .

is modification of pinned sphere. Tongues on fastening sleeves are bent over sphere on assembly. Greater sliding contact of tongues in grooves makes ample lubrication essential at high torques and alignment angles.



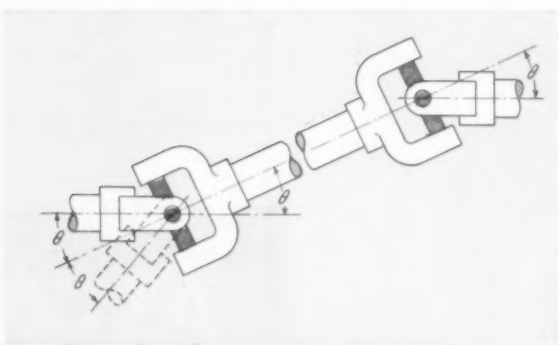
4

Pinned sleeve . . .

fastened to one shaft engages forked, spherical end on other shaft to provide joint that also allows for axial shaft-movement. In this example, however, angle between shafts can only be small. Also, joint is only suitable for low torques.

CONSTANT-VELOCITY COUPLINGS

The disadvantage of a single Hooke's joint is that velocity of driven shaft varies. Its maximum velocity can be found by multiplying driving-shaft speed by secant of the shaft angle; for minimum speed multiply by the cosine. An example of speed variation: Driving shaft rotates at 100 rpm; angle between shafts is 20°. Min output is 100 x 0.9397, which equals 93.97 rpm; max output is 1.0642 x 100, or 106.4 rpm. Thus the difference is 12.43 rpm. When output speed is high, output torque is low and vice versa. This is an objectionable feature in some mechanisms. However, two universal joints connected by an intermediate shaft solve the problem.



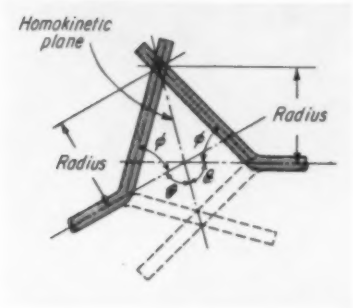
5

Constant-velocity . . .

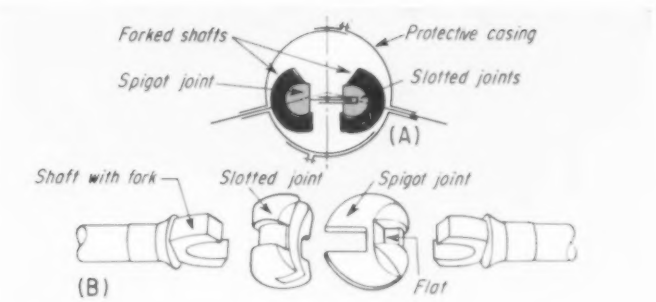
joint made by coupling two Hooke's joints must have input and output angles equal for correct action. Also, the forks must be assembled so that they will always be in the same plane. Shaft-alignment angle may be double that for a single joint.

SHAFT-COUPLINGS

others—for axial and angular play—described in the Aug. 4 issue.



6

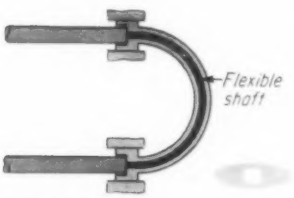


7

Single constant-velocity . . .

coupling is based on principle (6) that contact point of the two members must always lie on the homokinetic plane. Their rotation speed will then always be equal because radius to contact point of each member will always be equal. Such simple couplings are ideal for toy, instrument and other light-duty mechanisms. For heavy duty, such as front-wheel drive of military vehicles, a more complex coupling, shown diagramatically (7A) has two joints close coupled with a sliding member between them. Exploded view (7B) shows these members. There are other designs for heay-duty universal couplings; one, known as the Rzeppa, consists of a cage that keeps six balls in the homokinetic plane at all times. Another constant-velocity joint, the Bendix-Weiss, incorporates balls also.

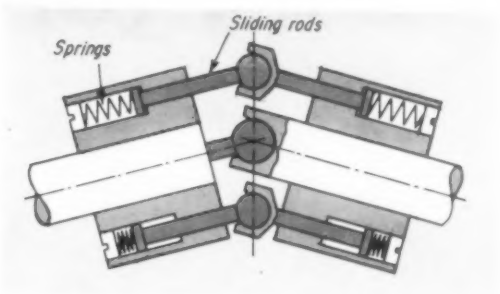
MISCELLANEOUS COUPLINGS



8

Flexible shaft . . .

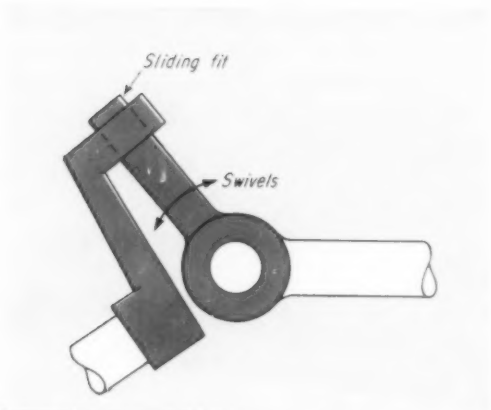
allows any shaft angle. Such shafts, if long, should be supported to prevent backlash and coiling.



9

Pump-type coupling . . .

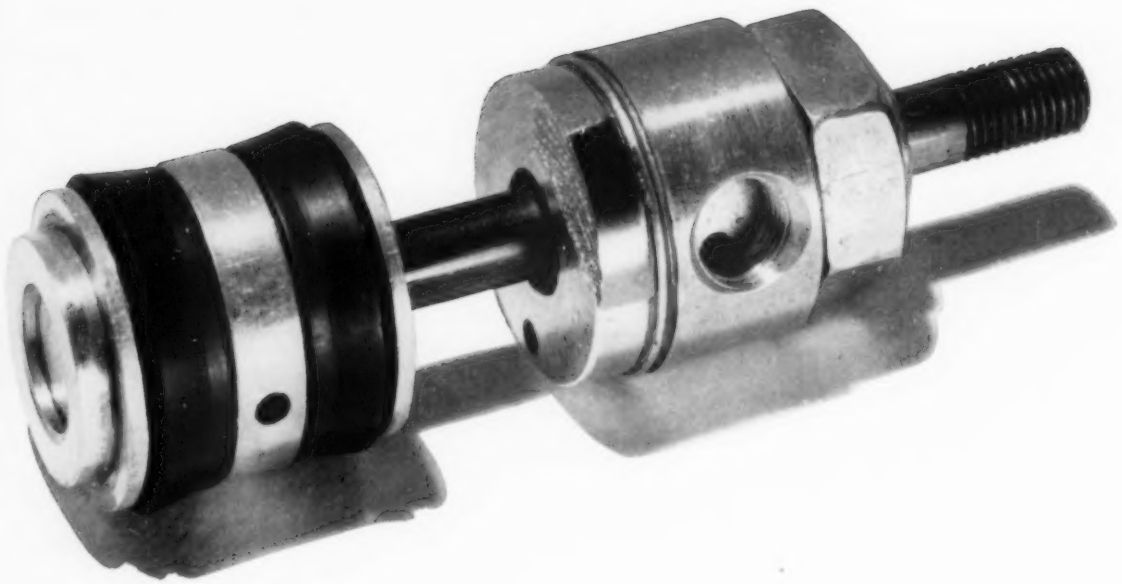
is so called because reciprocating action of sliding rods can be used to drive pistons in cylinders.



10

Light-duty coupling . . .

is ideal for many economical mechanisms. Sliding swivel-rod must be kept well lubricated.



Like NEW—after 1,600,000 Cycles!

. . . due to the right combination of packings and engineering

That's right, 1,600,000 cycles. The picture is about twice actual size, unretouched. The application: a Model 091-D double acting air cylinder produced by Bimba Manufacturing Co., Monee, Illinois.

The designer got excellent results for two reasons. One: he specified and insisted on a close, smooth inside finish. Two: he specified Houghton Vix-Syn "U" Cups.

He knew—as so many engineers are discovering—that Houghton Packings of any standard material—rubber, fabricated rubber, wax or rubber-impregnated leather—will give a bonus in long wear and reliability in correctly designed pneumatic and hydraulic equipment. And he also knew Houghton backs up packings with prompt engineering service when it's needed.

Why not make Houghton your packing headquarters? Don't settle for less than the foremost packing know-how in the business. Specify Houghton packings. Free folder gives engineering features and lists all sizes available. Write E. F. Houghton & Co., 303 West Lehigh Avenue, Philadelphia 33, Pa.

VIX-SYN "U" CUP PACKINGS

. . . products of

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PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

Ready to give you on-the-job service . . .

A rundown on . . . the CONJUGATE-BEAM METHOD

E. D. CLARK, *Research Div.*
United Shoe Machinery Co., Beverly, Mass.

With 4 examples showing how to apply this fast analysis of load problems.

When beam analysis requires no calculus, yet handles changing sections as readily as uniform ones, it adds up to quicker calculations. The conjugate-beam method described here gives such efficiency and can be extended by the superposition method to cover any kind of loading. (The superposition method, combining results of several simple methods to answer a more complex problem, is described more fully in, for example, *Strength of Materials* by Timoshenko and MacCullough.)

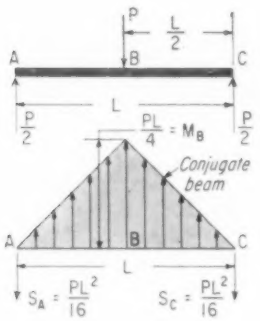
In the conjugate-beam method first construct the bending-moment diagram for a beam, then treat this diagram as if it were a beam carrying a distributed load—with shape of the diagram representing the distribution pattern. This imaginary beam is the "conjugate beam." The following is true of any point on such beams.

1. The slope (in radians) is numerically equal to the shear force (in force units).
2. The deflection is numerically equal to the bending moment.

The following examples show what steps to follow when solving beam problems with this method.

SYMBOLS

C = outer fiber to neutral axis, in.
E = Young's modulus, psi
$f = MC/I = EC/R$ = max fiber stress, psi
I = moment of inertia, in.^{4}
L = beam length, in.
$M = fI/C$ = bending moment, in.-lb
P = load, lb
$R = EI/M$ = radius of curvature, in.
S_A, S_C = supporting forces on conjugate beam
V = vertical forces, lb
α = slope, radians
δ = deflection, in.



I. Simple beam with concentrated load.

$$M \text{ (about } B) = \frac{P}{L} \cdot \frac{L}{2} = PL/4$$

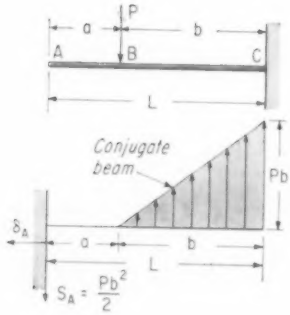
Draw bending-moment diagram and use this as conjugate beam.

$$S_A = S_C = \frac{PL}{4} \cdot \frac{L}{2} \cdot \frac{1}{2} = PL^2/16$$

Slope at $A = \Sigma V_B$; $\alpha_A = PL^2/16\,EI$
Deflection at $B = \Sigma M_B$,

$$EI\,\delta_B = \frac{PL^2}{16} \cdot \frac{L}{6} - \frac{PL^2}{16} \cdot \frac{L}{2} = PL^3/48$$

$$\delta_B = PL^3/48\,EI$$



II. Cantilever with concentrated load.

$M_c = Pb$
Draw conjugate beam (by plotting bending moment as shown).

$$S_A = Pb \cdot \frac{6}{2} = Pb^2/2$$

Slope at $A = \Sigma V_A$; $\alpha_A = Pb^2/2\,EI$
Deflection at $A = \Sigma M_A$

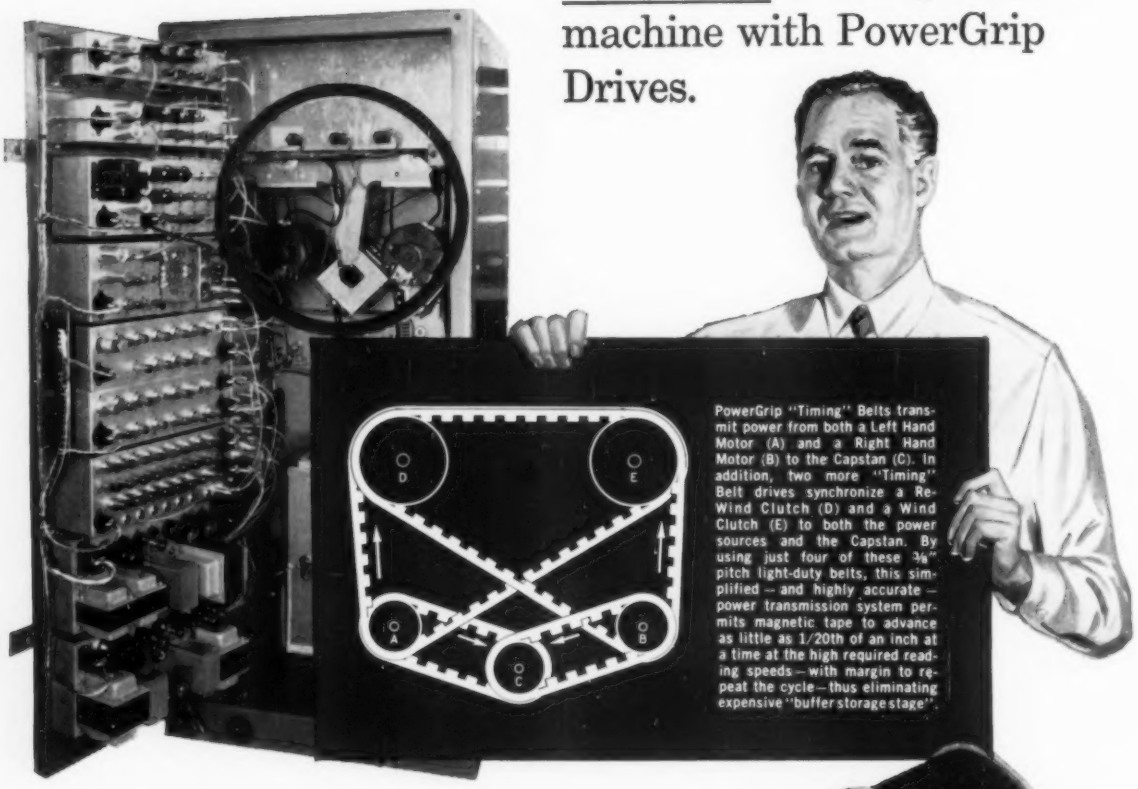
$$EI\,\delta_A = \frac{Pb^2}{2}\left(L - \frac{b}{3}\right)$$

$$\delta_A = \frac{P}{2EI}\left(b^2L - \frac{b^3}{3}\right)$$

(Continued on page 85)

US RUBBER **PowerGrip** "TIMING" BELTS

"GRIP" POWERS tells how they improved the sale-ability of this precision machine with PowerGrip Drives.



PowerGrip "Timing" Belts transmit power from both a Left Hand Motor (A) and a Right Hand Motor (B) to the Capstan (C). In addition, two more "Timing" Belt drives synchronize a Re-Wind Clutch (D) and a Wind Clutch (E) to both the power sources and the Capstan. By using just four of these ⅜" pitch light-duty belts, this simplified – and highly accurate – power transmission system permits magnetic tape to advance as little as 1/20th of an inch at a time at the high required reading speeds – with margin to repeat the cycle – thus eliminating expensive "buffer storage stage".

The Shepard Servo Transport Digital Tape Reader, shown here, is used to match the speed of electronic information being fed from high-speed data processing machines to the speed of the apparatus which transcribes the electrical impulses into readable typewritten copy.

By incorporating PowerGrip "Timing"® Belt drives into this system, the following sales advantages were gained:

- *no maintenance problems*... no lubrication, no take up or other special alignment required; drives will last for the life of the machine.
- *vibration-free transmission*... belts run smoothly and quietly with constant angular velocity.
- *handles high shock loads*... slippage and belt friction eliminated; steel cables imbedded in the belt provide high tensile strength.
- *lower cost* . . . PowerGrip costs ½ as much as previous drive; saving is passed to the customer.

Says E.J. Quinby, Product Manager: "We use these belts because exhaustive research by us has proven them superior in speed—accuracy—reliability – durability – silence – freedom from periodic adjustment."

Check the *sales advantages* PowerGrip "Timing" Belts can add to your designs.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

US RUBBER **Mechanical Goods Division**

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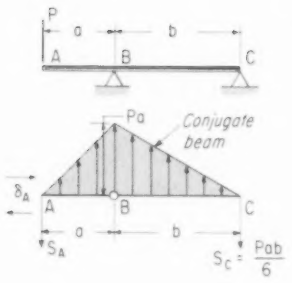
Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.



III. Span with cantilever overhang: $M_B = Pa$

Draw conjugate beam.

Point B is hinged because no deflection can exist at a support. (On the conjugate beam, bending moments are deflections.)

Point A has both slope and deflection so the conjugate beam must show both a bending moment and a shearing force at A.

Element BC.

$$\Sigma M_B = 0 = S_C b - \frac{pab}{2} \cdot \frac{b}{3}\ ;\ S_C = Pab/6$$

Shear at $B = -Pab/6 + Pab/2 = Pab/3 = S_B$

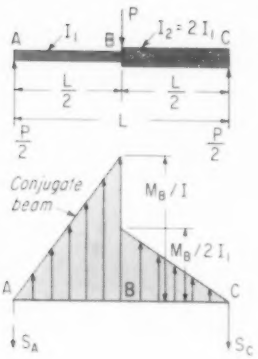
Slope at B is: $\alpha_B = Pab/3EI$

Element AB: $S_A = Pab/3 + Pa^2/2 = \frac{1}{6}\ P\ (2ab + 3a^2)$

Slope at A is $\alpha_A = \frac{P}{6EI}\ (2ab + 3a^2)$

Deflection at A is $EI\,\delta_A = S_B a + \frac{Pa^2}{2} \cdot \frac{2a}{3} = \frac{Pa^2 b}{3} + \frac{Pa^3}{3}$

$$\delta_A = \frac{P}{3EI}\ (a^2 b + a^3)$$



IV. Beam with center load, half of beam increased in section so that moment of inertia is doubled.

$M_A = M_C = 0$, $M_B = PL/4$, $I_2 = 2I_1$, E = constant

On the conjugate beam: Slope = shear/EI

Deflection = M/EI, therefore plot M/I diagram.

Evaluate S_A, S_C by $\Sigma M_A = 0$, $\Sigma_{MC} = 0$

$$S_C = \left(\frac{M_B}{I_1} \cdot \frac{L}{4} \cdot \frac{L}{3} + \frac{M_B}{2I_1} \cdot \frac{L}{4} \cdot \frac{2L}{3} \right) / L$$

$$= \frac{M_B L}{12\,I_1} + \frac{M_B L}{12\,I_1} = M_B L/6\,I_1$$

$$S_A = \left(\frac{M_B}{2\,I_1} \cdot \frac{L}{4} \cdot \frac{L}{3} + \frac{M_B}{I_1} \cdot \frac{L}{4} \cdot \frac{2L}{3} \right) / L$$

$$= \frac{M_B L}{24\,I_1} + \frac{M_B L}{6\,I_1} = 5\,M_B L/24\,I_1$$

Slope at $C = S_C/E = M_B L/6EI_1 = PL^2/24EI_1$

Slope at $A = S_A/E = 5M_B L/24EI_1 = 5PL^2/96EI_1$

Deflection at $B = \Sigma M_B/EI_1$

$$E\delta_B = S_A \cdot \frac{L}{2} - \frac{M_B}{I_1} \cdot \frac{L}{4} \cdot \frac{L}{6} = \frac{5\,M_B L^2}{48\,I_1} - \frac{M_B L^2}{24\,I_1}$$

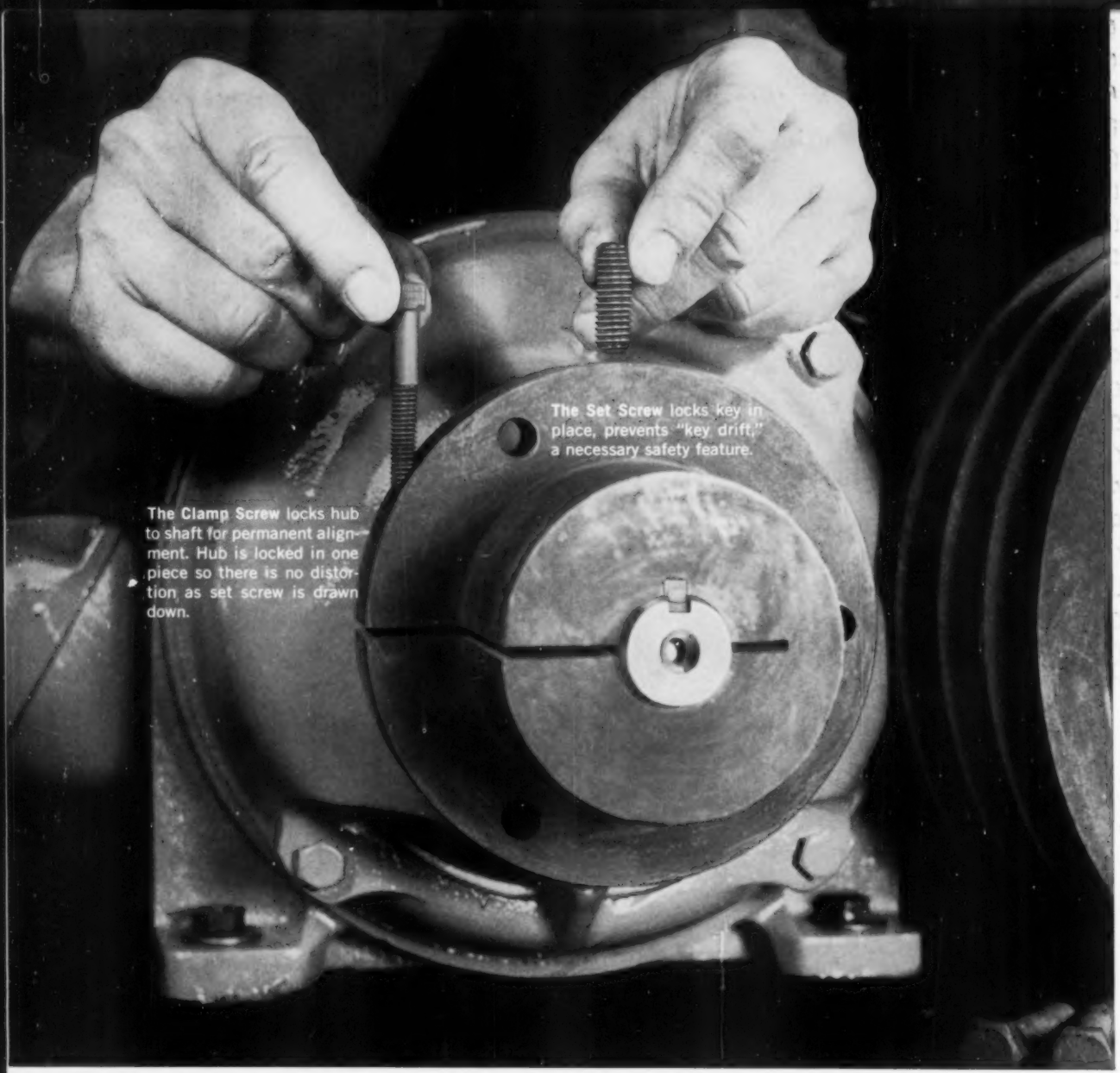
$$\delta_B = M_B L^2/16EI_1 = PL^2/64\,EI_1$$

EDITOR'S NOTE: Some recent articles that aid in beam-stress analysis include:

"Variable-section Cantilever Beams," Feb. 17, p 83. When spring action is more important than rigidity, use nonrectangular beams. Author supplies a first look at working equations derived to help choose among 4 variable-section types.

"Cantilevers That Roll with the Load," July 7, p 58, explains how a curved support under a cantilever spring protects it from overstress, and triples energy capacity. Article gives the why and how, along with design equations for 7 types.

"Figuring Deflections of Elastically Supported Cantilevers," Aug 4, p 63, gives 8 beam formulas.


The Set Screw locks key in place, prevents "key drift," a necessary safety feature.
The Clamp Screw locks hub to shaft for permanent alignment. Hub is locked in one piece so there is no distortion as set screw is drawn down.

In Worthington QD Sheaves these extra

2 SCREWS MAKE THE DIFFERENCE

Exclusive features of Worthington QD Sheaves...

EASY ON! Two-piece design lets you install the sheave *one part at a time*. No heavy rim and hub combination to inch into place; the tapered hub slides easily on the shaft, is locked by the clamp screw for permanent alignment. The set screw locks key. Then the sheave rim slides easily into position on the taper-seat of hub because the large end of taper in sheave starts engagement with small end of taper on hub. Heavy hex-head bolts complete the assembly.

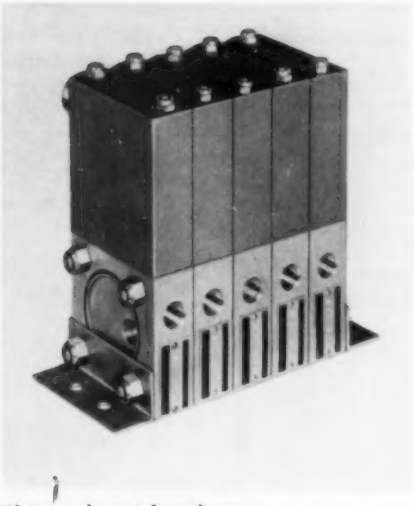
EASY OFF! Remove the big pull-up bolts and use two as jack bolts for easy rim removal. To change speed it's simple to mount a larger or smaller sheave on the hub which, because of clamp screw, remains aligned on shaft. You can install or remove one part at a time.

ALWAYS TIGHT! Severe shock or reversing loads cannot loosen the sheave. Tightening the pull-up bolts locks the hub to the shaft as tight as if the sheave were integrally cast with shaft. The set screw anchors the key in position.

COMPLETE STOCK! You can get Worthington QD sheave stock service anywhere in the U. S. More than 350 distributors carry Worthington sheaves and Worthington-Goodyear Green Seal V-belts. For 100 page Multi-V-Drive Manual on how to select the right sheave and V-belt write to Section 79-10, Worthington Corporation, Harrison, N. J.

WORTHINGTON

CIRCLE 144 READER SERVICE CARD



Thin solenoid valves . . .

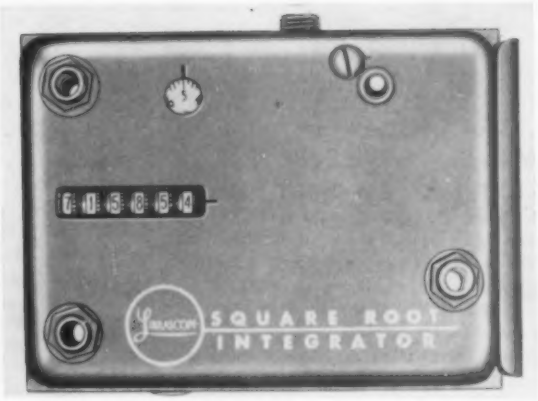
can be used with air or oil for pressures to 125 psi; temperatures to 150 F. Furnished tapped for either ⅛ or ¼ in. pipe connection. Rated 300 cpm for continuous operation; up to 700 cpm for intermittent service on air at 120 psi. Housing is machined from aluminum bar stock. Chambers are formed with metal spacers held in metal-to-metal end abutment. Solenoid is enclosed in a brass housing and positioned on two resilient O-rings with a spring. Normally closed or normally open, three-way designs are offered at $29.50 each or with four-way action at $34.50 each. Valves can be manifolded without special parts. Measures 1 x 3 x 6⅛ in. high. **C. B. Hunt & Son, Inc., Salem, Ohio.**

Circle 1, inside back cover

Magnet-run mercury switch . . .

operates even when tilted 45° from vertical position. Metal end caps hermetically seal operating parts and mercury in enclosure. Movable contact reaches mercury by penetrating opening in capillary tube, positioned to be supplied by mercury in well. Adaptable to applications where mechanical movement of about ½ in. with a force of 2 gm is available to move permanent magnet. Switches can also be operated by dc electromagnets. Electrical connections to the switch are made through metal end caps, eliminating lead wires. Offered in normally open and normally closed models. Electrical ratings are 115 v ac carrying 0.3 amp, dc carrying 0.15 amp; 230 v ac carrying 0.15 amp, dc 0.07 amp; 24 v ac carrying 0.9 amp, dc 0.45 amp. Over-all length, 1¼ in.; weight, about 0.15 oz. Price, $2.95; delivery, 3 to 4 wk. **Mercoid Corp., 4201 Belmont Ave., Chicago 41.**

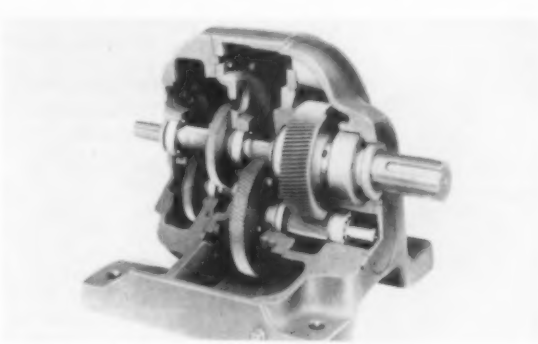
Circle 2, inside back cover



Square root integrator . . .

totals flow continuously and automatically. Specifically for standard flowmeters that utilize output of conventional sensing elements. Integrator utilizes double disk-and-ball integrating mechanism. With a given speed on lower disk, upper disk and counter turn at a speed proportional to square root of the displacement of balls from center of the disk. Linearity is 0.25% of full scale. Max recommended input speed of 60 rpm, combined with a full scale ratio between time shaft and counter of 2:1, provides a max rate of 300 counts per min. Input shaft torque is 0.35 in.-oz. max and shaft rotation is 18½°. Max time shaft torque is 0.5 in.-oz. Operates within temperatures of from −40 to 150 F. Integrator is $270. Delivery in 60 days now; in 15 days when full production is reached. **Librascope, Inc., Commercial Div., 40 E. Verdugo Ave., Burbank, Calif.**

Circle 3, inside back cover

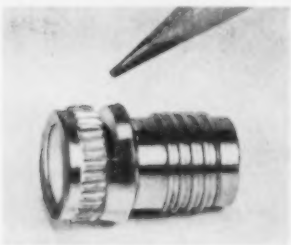


Quadruple reduction drive . . .

in five output torques from 2400 to 3600 in.-lb offers ratios from 195:1 to 2217:1 at speeds of 1750, 1150, 870 and 580 rpm. Four helical gear trains operate in high-capacity ball and roller bearings mounted in a cast iron housing. Input and output shafts are on same horizontal and vertical planes. Moving parts are splash-lubricated. Priced from $316 to $990, depending on size. Available from stock to 10 days. **Link-Belt Co., Prudential Plaza, Chicago 1.**

Circle 4, inside back cover

. . . CONTINUED ON PAGE 88



Miniature panel lights . . .

produce a small, flat wedge of light parallel to panel. Receptacle uses standard 327 and 328 type bulbs. Light source is invisible from front as top cap is slotted (indicated by pencil) on one side. In 55 different configurations to fit various illumination applications. All models have nylon coding collars, in standard RETMA colors, behind the panel to simplify wiring. Most models offer 180° visibility. **Sloan Co., 4101 Burbank Blvd., Burbank, Calif.**

Circle 5, inside back cover

Self-insulating fasteners . . .

combine plastic heads and metal shanks to provide mechanical properties of metal and dielectric advantages of plastic. Most thermoplastic materials can be used in molding the fastener heads. Plastic heads withstand impact, have good thermal insulating properties, prevent corrosion and moisture absorption in mechanical and electrical assemblies. Plastics also prevent galling when contacting decorative or easily-marred surfaces. Offered in various colors. **Gries Reproducer Corp., 400 Beechwood Ave., New Rochelle, N. Y.**

Circle 6, inside back cover

Worm and planetary gear . . .

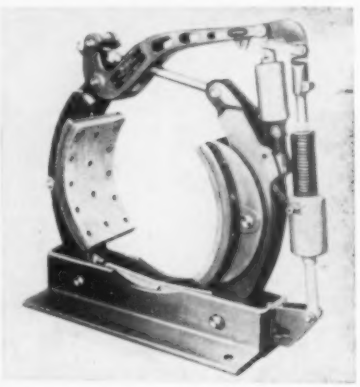
has a 220:1 ratio and incorporates a counterclockwise input and output. Said to be conservatively rated at 225 ft-lb at 8 rpm output. Max output torque rating has not yet been determined, limiting factor being characteristics of lubricant used. Heat-treated worm is high carbon alloy steel. Worm gear features two-piece construction, with gear portion made of a bronze alloy. Sun gear material is alloy cast iron containing chromium and vanadium. **Merkle-Korff Gear Co., 213 N. Morgan St., Chicago 7.**

Circle 7, inside back cover

Tapped transformers . . .

correct available electrical voltage where it is above or below normal required for proper operation of an appliance or electrical equipment. Series shown, rated from 350 to 750 va, has a tapped primary for use on 260, 240, 220, 200 v circuits and a tapped secondary to provide for 125, 115, 105, 95 v output. Rated for motor hp from $\frac{1}{3}$ to $\frac{1}{2}$. Also available to convert 208 v to 230 v. **Acme Electric Corp., Cuba, N. Y.**

Circle 8, inside back cover



Air-braking systems . . .

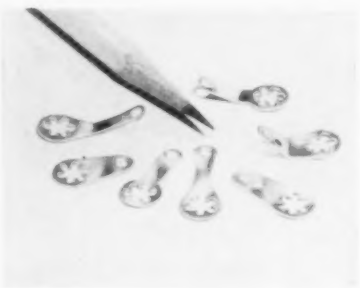
for heavy industrial equipment are available with the 14 x 6 in. or the 18 x 8 in. external shoe brake. One system is for making service stops only. Brake is applied by an air-actuating cylinder that incorporates a return spring for quick release. Second system encompasses both service stops and parking and holding operations. In addition to air-actuating cylinder, it has a spring-applied, air-released parking cylinder. With the exception of the cylinders, all parts are interchangeable with hydraulic brakes of like size. Systems are furnished complete, with all parts, fittings and instructions, ready for installation. **Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14.**

Circle 9, inside back cover

Miniature gearboxes . . .

with ratios from 1.5:1 to 600:1 will mate with any standard size 8 ac or dc motor and can be adapted to any motor end configuration. Units may weigh as little as $\frac{3}{4}$ oz with aluminum housing. Stainless steel housings are available and all gears are stainless. Class 5 miniature bearings are used. Backlash is as low as 45 min and units will handle 50 in.-oz torque. Starting torque is 0.015 in.-oz or less, depending on ratio. Output shaft dia of 0.0937 and 0.1250 are offered and shaft may be concentric or offset from housing. Depending on the ratio, length may be as short as $\frac{1}{2}$ in. **Ellison Engineering, 4350 San Fernando Rd., Glendale, Calif.**

Circle 10, inside back cover



Lock-washer terminals . . .

in 0.018 brass or phosphor bronze, hot tinned, with No. 4, 6 or 8 holes, now available from stock. Shapes are designed to fit most needs. Sample kit available. **Zierick Mfg. Corp., 110 Beechwood Ave., New Rochelle, N. Y.**

Circle 11, inside back cover

Pump and motor . . .

operate from a 12-v battery. Developed originally for hydraulic applications on small mobile hoists. Rated for 30 cu in./min at 500 psi. Motor has a rating of $\frac{1}{8}$ hp. Unit uses 10W lubricating oil as a hydraulic fluid. Operates in temperatures to 200 F. Motor has been designed into a rotary-gear pump and combined unit measures $3\frac{3}{16}$ x $7\frac{5}{16}$ in. **Tuthill Pump Co., 963 E. 95 St., Chicago.**

Circle 12, inside back cover

Measures multiple pressures . . .

using only one transducer. Also is reported to increase accuracy of measurement by venting transducer to atmosphere between successive ports and, thus, substantially reducing hysteresis effects. Has low internal volume and negligible effect on pneumatic response time of conventional pressure systems. Can be externally programmed to switch pressures in any desired sequence or can be operated by means of a manual switch to select pressures to be measured. Basic dimensions

. . . CONTINUED ON PAGE 90

2 Giant Waldes Truarc Beveled Rings Cut Costs $500, Save 76½ Hours Machining-Assembly Time on X-Ray Unit

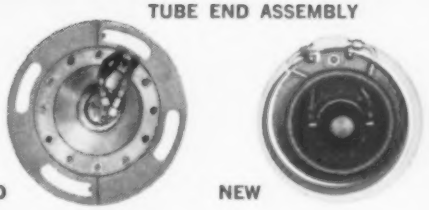
TRIPLETT & BARTON TRI-IND-X PORTABLE X-RAY UNIT

OLD MODEL NEW MODEL

	OLD SPECIFICATIONS	NEW SPECIFICATIONS
Weight	107 lbs.	65 lbs.
Diameter	15 inches	11 inches
Machining and Assembly Time	78 hours	1½ hours
Service Time	4½ hours	5 minutes
Parts	27 bolts	2 Truarc Rings

Prior to adoption in their new bantam-weight TRI-IND-X, Triplett & Barton, Inc., Burbank, Calif., subjected Waldes Truarc Retaining Rings to severe tests and rigid inspections. Although the TRI-IND-X operates at a normal pressure of 50 psi, Truarc Rings were subjected to pressure tests in excess of 500 psi, proving their high performance.

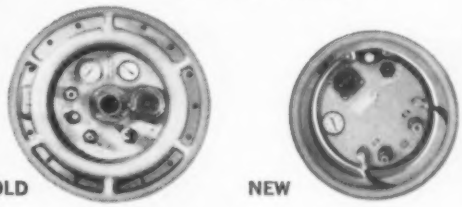
TUBE END ASSEMBLY



OLD NEW

ONE 10" BEVELED RING REPLACES 12 BOLTS—Machining and assembly time formerly required 78 hours . . . now reduced to 1½ hours! Service operations for dismantling or tube change formerly required 4½ hours . . . now reduced to 5 minutes! In addition to savings on materials, costs have been reduced approximately $500 per unit.

END BELL ASSEMBLY



OLD NEW

ONE 9" BEVELED RING REPLACES 15 BOLTS—In addition to functioning as mechanical fasteners, the Truarc Beveled rings serve as pressure vessel closures, providing leak-proof seals. The wedge action of the ring compensates for wear, provides a constant tight seal.

Whatever you make, there's a Waldes Truarc Ring designed to save you material, machining and labor costs, and to improve the functioning of your product.

In Truarc, you get

Statistically Controlled Quality from engineering and raw materials to the finished product. Every step in manufacture watched and checked in Waldes' own modern plant.

Complete Selection: 36 functionally different types. As many as 97 standard sizes within a ring type. 5 metal specifications and 14 different finishes. All types available quickly from leading OEM distributors in 90 stocking points throughout the U. S. and Canada.

Field Engineering Service: More than 30 engineering-minded factory representatives and 700 field men are at your call.

Design and Engineering Service not only helps you select the proper type of ring for your purpose, but also helps you use it most efficiently. Send us your blueprints today . . . let our Truarc engineers help you solve design, assembly and production problems . . . without obligation.

WALDES

TRUARC®

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L.I.C.1, N.Y.

Please send new, descriptive catalog showing all types of Truarc rings and representative case history applications.

(Please print)

Name_____

Title_____

Company_____

Business Address_____

City_____ Zone____ State_____

PN-980

Consult the Yellow Pages of Your Telephone Directory for Name of Local Truarc Factory Representative and Authorized Distributor. Look under "Retaining Rings" or "Rings, Retaining."

Maxitorq

Disc-pac...

the pre-packaged clutch or brake assembly

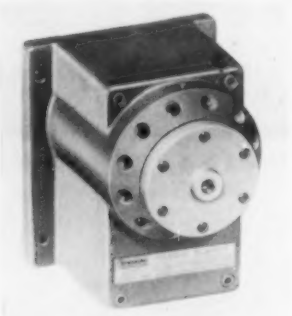
Takes performance guesswork out of power transmission design

With these performance-proved units, you can save time and money in designing and building clutches and brakes exactly tailored to the requirements of your application. At the same time, you can be sure that they will equal the performance and smooth operation of proved MAXITORQ clutches and brakes. DISC-PACS are simply the "heart" of a clutch or brake . . . the discs, separator springs, and locking plate . . . supplied as a complete self-contained unit for the convenience of design engineers and equipment builders.

Produced in a full range of sizes and capacities from ¼ h.p. to 15 h.p. Bulletins available on other MAXITORQ products: Floating Disc clutches and brakes, Electric clutches, Overload Release clutches, low-cost Single Disc clutches, and clutch or brake friction discs. Write Dept. PE-8.

THE CARLYLE JOHNSON MACHINE CO.
Manchester, Connecticut

ECJ98



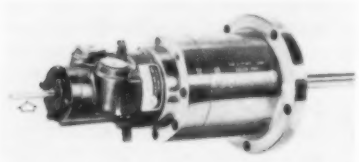
are 6¼ x 5⅛ x 5½ in. Designed with ⅞ in. 24NF-3 thread pressure connections. Operational range is from vacuum to 350 psi for dry air and non-corrosive dry gases. **Datex Corp., 1307 S. Myrtle Ave., Monrovia, Calif.**

Circle 13, inside back cover

Solid-state counter . . .

incorporates printed readout as an integral design element. Furnished with single or dual preset up to six digits. Presetting is indicated through illuminated number dials. Batches, total or progress count may be read on the back-lit numerical display. Printer can be set to print batch totals at periodic intervals with index number for elapsed time, or to clear upon printing. Requires no internal adjustments. Designed to operate under line voltage fluctuations of ±15% from nominal 117 or 220 v ac line. Input signal is between +50 v and −50 v. Counting rates up to 100 kc are possible. Size is 19 x 12 x 16 in. Weight is 21 lb. **Presin Co., 12128 W. Pico Blvd., West Los Angeles 64.**

Circle 14, inside back cover

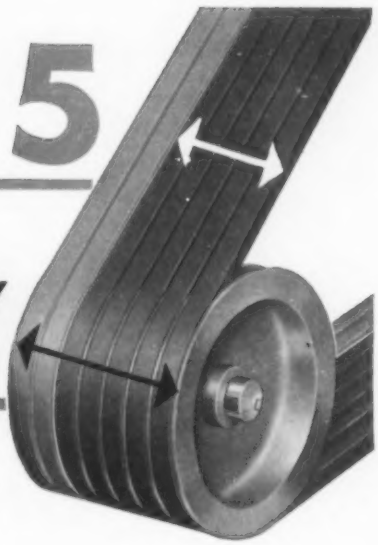


Actuator/indicator rod . . .

for rotating cylinders actuates limit switches and similar control devices in conjunction with cylinder operation or to indicate piston position. Piloted and pinned to piston assembly, rod protrudes through inlet housing end cap. Standard rod is ½ in. dia. with optional plain or threaded end. Rod and piston travel are identical and rod lengths are furnished to meet customer requirements. Cylinders are offered in standard bore sizes of 3, 4½, 6 and 8 in. with 1, 1½ or 2 in.

(Continued on page 94)

Drive with 5 instead of 7



Use fewer V-belts... get equal horsepower
Save space and costs

You cut sheave width and weight . . . you save in overall costs . . . by using Gates Super Vulco Ropes with 40% more HP capacity. Five Supers actually do the work of 7 standard V-belts.

For that reason, a Super Vulco Rope Drive delivers more HP per dollar invested than any standard V-belt drive.

Sheaves with fewer grooves cost less . . . weigh less . . . occupy less space. Your drive design is greatly improved.

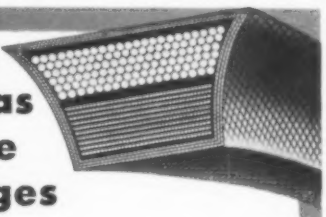
You can get helpful drive data quickly. Just call your nearby Gates distributor for advice from a Gates V-Belt Specialist.

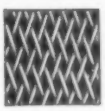
Stocks carried in industrial centers throughout the world.

The Gates Rubber Company
Denver, Colorado
World's Largest Maker of V-Belts

Gates — The Mark of *Specialized* Research

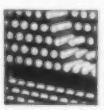
No other V-Belt has ALL these advantages





1. Flex-Weave Cover (U.S. Pat. 2519590)
A Gates exclusive: provides greater flexibility with far less stress on fabric. Cover wears longer... increases belt life...more power available to driven machine.

2. Concave Sidewalls (U.S. Pat. 1813698)
Concave sides (Fig. 1) increase belt life. As belt bends, concave sidewalls become straight, making uniform contact with sheave groove (Fig. 1A). Uniform contact means less wear on sides of belt... far longer belt life.



3. Tough, resilient Tensile Cords
Super-strong resilient tensile cords provide 40% greater horsepower capacity ...easily absorb heavy shock loads... reduce number of belts required... save weight and space.

4. High Electrical Conductivity
Built into Gates Super Vulco Ropes for safer drives (in explosive atmospheres).

5. Oil, Heat, Weather Resistant
Special rubber compounds make Super Vulco Ropes highly resistant to heat, oil, and prolonged exposure to weather.

TPA 306

Gates Super VULCO ROPE Drives
40% more Horsepower Capacity

USED ON THE NEW BOEING B-52 JET BOMBER

New MS Miniature Plug

WITH SOLDERLESS SNAP-IN CONTACTS

Cuts Wiring Assembly Time as much as 80%

CANNON KM SERIES
FIRST TO MEET MIL-C-25955 (USAF) SPECIFICATIONS

THE PROBLEM—To design a miniature environmental-resistant connector, suitable for use on present and future aircraft, missiles and equipment, in accordance with military requirements. Dependability with simplicity to facilitate assembly, installation and field service were vitally important.

THE SOLUTION—Crimp-type solderless contacts, with wire insulation support, are used in the new KM. They can be easily snapped into place, or removed as necessary. Individual contacts can be serviced one at a time, without removing others. A specially designed moisture-sealing grommet replaces potting. Closed entry, machined socket contacts are probe-proof. All materials are of finest obtainable quality. Shells and related parts are of aluminum alloy, cadmium plated. Contacts are plated with gold over a heavy silver undercoat.

These features combine to provide a plug of optimum reliability that can be assembled and installed with utmost speed and be easily serviced in the field.

The new KM mates with the Cannon KO Plug Series, and is available in a wide variety of shell sizes, styles and insert layouts. Hermetically sealed receptacles also available. *For complete information write for Catalog KM-1.*

Come to Cannon for all plug needs—27,000 kinds to choose from. If we do not have what you want we'll make it for you. The largest facilities in the world for plug research, development and manufacturing are at your service. Write us today about your problem. Refer to Dept. 106

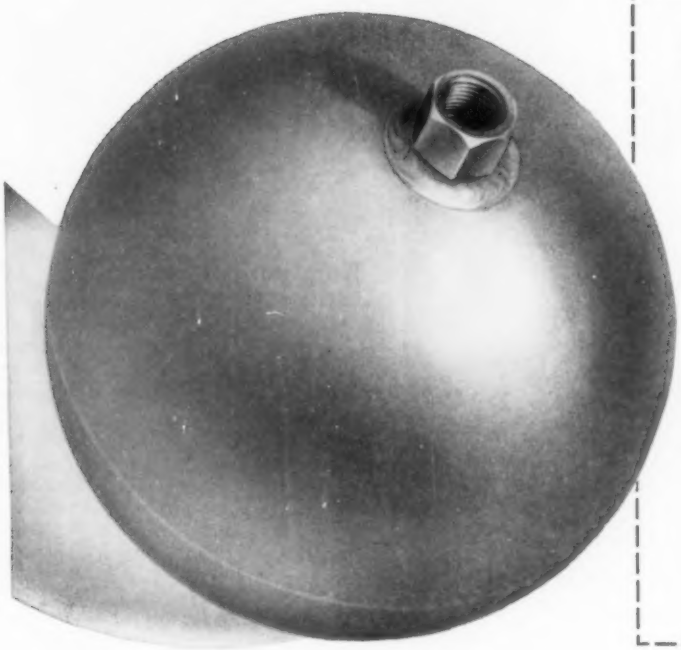
CANNON ELECTRIC COMPANY • 3208 Humboldt Street, Los Angeles 31, California
Where Reliability for YOUR Product is Our Constant Goal.
Factories in Los Angeles; Salem, Mass.; Toronto; London; Melbourne; Paris; Tokyo. Representatives and distributors in all principal cities. Please see your Telephone Yellow Book or write factory.

CANNON PLUGS

AUDIO-VIDEO · AIRCRAFT · SWITCHING · POWER · MISSILE · UNIT PLUG-IN · INDUSTRIAL

MADE BY THE WORLD'S LARGEST MANUFACTURER OF PLUGS AND CONNECTORS FOR ALL INDUSTRIES

need floats?



Name the way you want them!

MATERIAL_____
SHAPE_____
SIZE_____
PRESSURE_____
QUANTITY_____
MORE INFO_____

*Your Name*_____
*Title*_____
*Company*_____
*Address*_____

See below for details

Fill in blanks, tear out, and mail to:

W. H. NICHOLSON and COMPANY
Wilkes-Barre, Pa.

Nicholson can deliver precision welded floats—made to your specifications—to fit your production schedule. Use the above form to tell us how you want them.

Here are the standard specs:

- **MATERIAL**—steel floats with chromium, cadmium or copper plating—with sandblast or pickled finish . . . stainless steel and Monel floats—rough-buffed, polished or with welds ground smooth and highly finished.
- **SHAPE**—spherical, elliptical, cylindrical.
- **SIZE**—from 2 inches to 14 inches diameter.
- **PRESSURE**—from vacuum to 4800 lbs.
- **QUANTITY**—as many as you need.

These high tensile strength floats have exceptional resistance to pressure and corrosion. Float halves are die-formed, with inward rolled edges—not spun, laminated or electrodeposited.

Today, thousands of Nicholson floats are in service—most as buoyancy mediums . . . many as fluid chambers and pressure vessels. Write for details about the full Nicholson line.

W. H. NICHOLSON AND COMPANY, 12 OREGON ST., WILKES-BARRE, PA., *Sales and Engineering offices in 98 principal cities.*

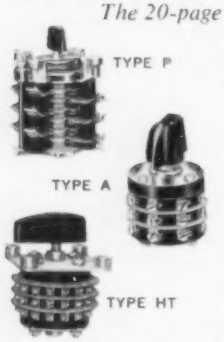
NICHOLSON
of Wilkes-Barre

ESCO ROTARY SWITCH CATALOG

Includes detailed engineering data, electrical ratings, dimensioned drawings of switches and knobs, cutaway and exploded views

A deviation from one of these standard assemblies will give you a special switch at standard switch cost.

The 20-page catalog includes these standard multipole switches:



- **Type P** — multisection, up to 4 positions, snap action, rating 10 amp. 125 v. a-c, 5 amp. 125 v. d-c, 30, 60, 100, 200 amp. 500 v. a-c/250 v. d-c. Can be assembled per MIL-S-15291.
- **Type JR** — up to 8 positions, 30 sections maximum, detent action, rating 10 amp. 125 v. a-c, 5 amp. 125 v. d-c.
- **Type A** — up to 8 positions, 7 sections maximum, detent mechanism, rating 5 amp. 125 v. a-c/30 v. d-c.
- **Type AF** — up to 8 positions, 6 sections maximum, detent action, resistive rating 5 amp. 28 v. d-c or 115 v. 400 cps, per MIL-S-6807.
- **Type HT** — up to 16 positions, 10 sections maximum, dentent action, rating 5 amp. 125 v. a-c.
- **Navy switches** — to MIL-S-15291 and Bureau of Ships drawings 9000-S6202-73075, 73826, 73827, 73295, 74422, and others.
- **Trigger switch** — heavy-duty momentary contact, with 4-conductor cable; meets Navy specs.

Write today for your free copy of this new, 20-page catalog

ESCO of WEYMOUTH
ELECTRO SWITCH CORPORATION
167 King Avenue, Weymouth 88, Massachusetts

strokes. Working pressure to 500 psi is permissible at temperatures to 150 F. Said to be suitable for use where lateral movement must be imparted to a rotating unit. **S-P Mfg. Corp., 30201 Aurora Rd., Solon, Ohio.**

Circle 15, inside back cover

Transistorized flasher . . .

is designed for use with a warning light. A flashing signal is given when unit is energized. A relay contact is only moving part. Uses a printed circuit board, silicon diodes and silicon transistors. Power consumption is 1 w, max. Unit is potted. Operates on inputs of 18 to 32 v dc in ambient temperatures of −65 to 160 F. Weighs 7 oz. Stud terminals, with barriers between, are provided for leads. Two screws secure unit to panel. **Master Specialties Co., 956 E. 108 St., Los Angeles 59.**

Circle 16, inside back cover

0.06-oz basic switch . . .

is said to have a 2½ million-cycle mechanical life. It may be obtained with any standard actuator. Simplified ganging is achieved by using a No. 1 screw passing through in-line holes in switches. Base size is 0.526 x 0.250 x 0.323 in. high. Contacts are SPDT. Operates in ambient temperatures of −65 to 250 F. Release force is 1.06 oz. Has high impact resistance. Contact pressure is 1.76 oz. Electrical rating is 6 amp at 125 to 250 v ac, 30 v dc resistive; 3.5 amp at 30 v dc inductive at sea level; 3.0 amp at 30 v dc inductive at 50,000 ft; 2.5 amp at 30 v dc inductive at 100,000 ft. **Switch Div., Electrosnap Corp., 4230 W. Lake St., Chicago 24.**

Circle 17, inside back cover

Nonlinear potentiometer . . .

delivers 0.5% peak-to-peak accuracy without pads or cams. The 2-in. dia sine-cosine unit has a range of up to 70 K ohm per quadrant. Unitized construction eliminates ganging problems. Each has a removable, external molded Kel-F coupling that per-

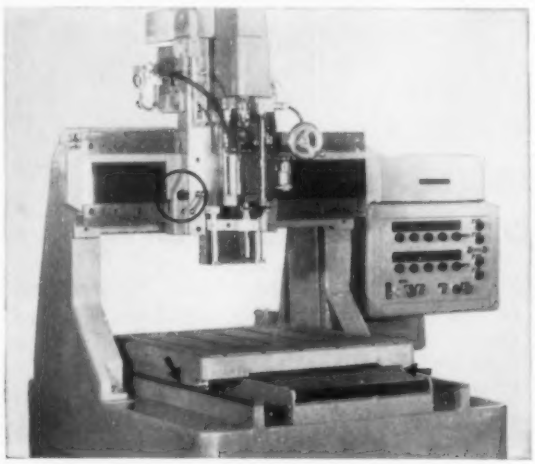
(Continued on page 99)

BEARING TIPS
by McGill

McGILL sealed CAMROL® bearings protect roller follower efficiency — prelubricated to reduce maintenance

Sealed SCF series bearings add protection from contamination to the extra performance advantages of McGill CAMROL cam followers. Specially treated labyrinth seals at the roller ends keep out moisture, dirt, chips, etc. All exposed surfaces are treated to provide a corrosion resistant black ferrous oxide finish.

The sealed construction with a channeled grease reservoir in the outer race bore eliminates need for frequent relubrication. Maintenance is reduced and can be eliminated in inaccessible mountings. Specify standard bearings and avoid building up followers with extra seals.



Sealed CAMROL bearings as table and crosshead rollers in tape-controlled Hillyer drilling machine

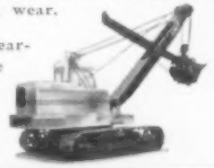
CAMROL bearings provide smooth, accurate motion as load carrying rollers for table and crosshead motion of this tape-controlled, precision drilling machine manufactured by HILLYER CORPORATION. Use of these bearings has simplified construction and improved accuracy. They have eliminated the manufacture of shaft and retainer assemblies and increased load capacities. The corrosion resistant finish has also eliminated the need for plating bearings. Ball bearings formerly used cracked under the same loads. Operating speeds are 400 RPM and loads are 2000 pounds. The bearings are prelubricated and sealed to keep maintenance at a minimum.

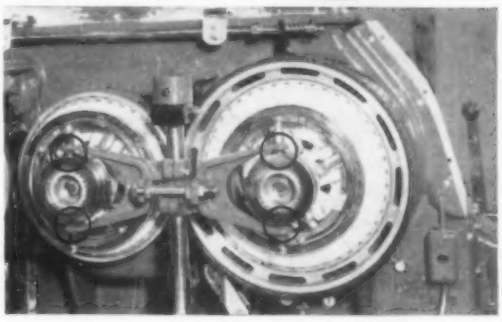
Sealed CAMROL bearings replace bronze rings in shovel clutches

UNIT CRANE & SHOVEL CORPORATION is using SCF SEALED CAMROL bearings in clutch shifter yokes in their ½ and ¾ yard power cranes and shovels and Model 360 MARINER 30-ton cranes. Shown is a closeup of two of the five clutches which control the hoist drum and the hold drum and various actions of the machines. The bronze collars formerly used were higher in initial cost than the CAMROL bearings. Their use also required considerable machining and the addition of component parts such as bolts, spacers, etc.

The CAMROL bearings in this application promise better, more accurate control than the bronze shifter rings which tend to become "sloppy" with wear.

The integral seal feature of the bearings protects their performance under field conditions and reduces relubrication requirements.





engineered electrical products

McGILL®

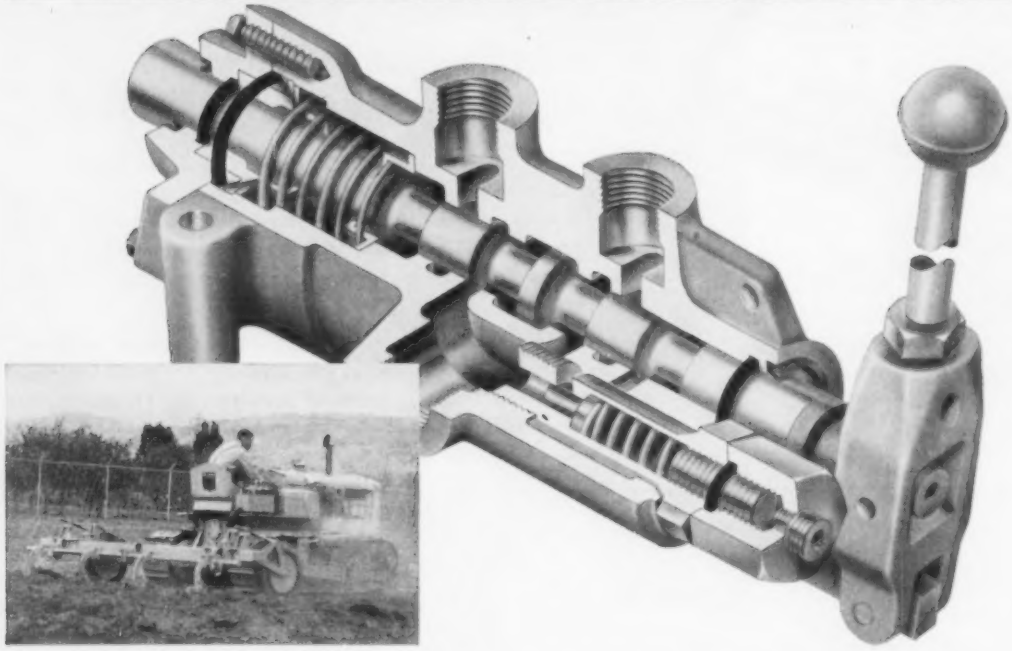
precision needle roller bearings

SEND FOR CATALOG No. 52-A

MULTIROL — GUIDEROL — CAMROL

McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA

NATIONAL OIL SEAL LOGBOOK



Use of O-rings as moving seal in heavy duty bulldozer control valve

1,500 psi variation without backup rings. Intermittent operation plus long periods of inactivity. Extreme external dust and dirt conditions. Irregular and unpredictable field servicing. Fluid oil temperatures reaching 180°F. Climatic temperature extremes from —30° to +120°F. Life expectancy is required to be that of the tractor.

Above are the rugged operating conditions faced and met by National industrial O-rings in the new Be-Ge Model SU-1200F bulldozer blade control valve. A total of four rings are employed in each unit; two in a moving shaft application and two as static seals.

Be-Ge reports no leakage or ring failure on hundreds of heavy duty applications involving Oliver, Caterpillar, International Harvester and other crawler tractor installations.

National offers a complete line of industrial O-rings, plus many exclusive compounds. Special compounding is also available to meet unusual conditions.

For complete information on National O-Rings, or for skilled O-ring engineering service, call your nearest National Seal engineer. In major cities nationwide. See the Yellow Pages, under "Oil Seals".

Syntech® Oil Seals

Syntech oil seals, developed by and offered exclusively by National, are widely used synthetic rubber seals for applications where temperatures reach 250°F, speeds reach 3,600 FPM, and total indicator runout is as high as .030. Basic 50,000 series Syntech (illustrated) employs a tough, accurately manufactured steel outer case, precision-tensioned spring and accurately molded and trimmed Syntech sealing lip.

Micro-Torc Oil Seals

Micro-torc oil seals, pioneered by National, are sturdy, dependable leather seals. Special elastomer coating on *surface* of chrome re-tanned leather sealing lip prevents seepage of oil. Yet inner body of sealing lip retains natural porosity to "store" lubricant against accidental periods of starvation. Inherent lubricity of elastomer coating produces a lower torque, longer lasting, economical oil seal. Available in a wide variety of types and sizes.

NATIONAL SEAL
Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Redwood City and Downey, California

4624

POWER FOR MISSILE & AIRCRAFT HYDRAULIC SYSTEMS

Eastern Aviation Hydraulic Pumps set new standards for performance, yet are the smallest, most lightweight ever made.

By meeting customer requirements and government specifications with precise detail, Eastern Pumps give reliable long-term service.

Hundreds of models, close-coupled to electric motors with speeds to 24,000 RPM, can be furnished for your special systems. You gain the advantage of economical mass-produced components custom-engineered into whatever configuration is needed. Performance is from .015 to 1.5 GPM, 0 to 3000 PSIG, with theoretical displacements from .0021 to .0419 cubic inches per revolution. A variety of bearing combinations handle different types of fluid and operating pressures.

Missile and aircraft system engineers have discovered Eastern Pumps do the same job as units that use greater space and weigh far more. Applications have included circulating coolant in bomber guidance system, providing hydraulic power for ground control of jet, charging accumulator in an in-flight refueling system, furnishing an APU system with power to a missile, and countless others.

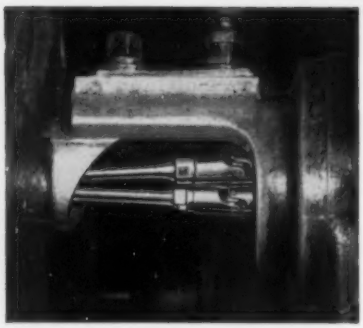
For your next project, contact Eastern for creative engineering help that really helps.

Write for NEW Aviation Bulletin 350 describing the above units and larger-capacity pumps.

EASTERN INDUSTRIES, INCORPORATED

100 Skiff Street • Hamden 14, Conn. West Coast Office: 1608 Centinela Avenue • Inglewood 3, California

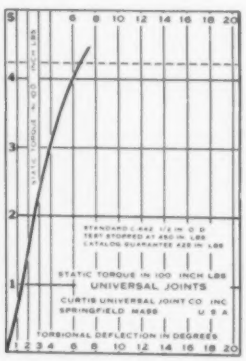
Solving a breakage problem AT CLOSE QUARTERS



The manufacturer of this button-drilling machine had a tough problem: the universal joints on these parallel shafts carried such a torque load there were frequent complaints of breakage . . . yet the close centers prohibited use of a larger joint.

THE SOLUTION was a Curtis Universal Joint of the same size.

Torque Curve ½" Curtis Universal Joint



This is only one of many problems solved by Curtis Joints — size for size the strongest universal joints designed for industry. Selected materials, precision engineering, and over 30 years' experience manufacturing universal joints make them that way.

14 SIZES ALWAYS IN STOCK — 3/8" to 4" O.D. (6" joints on special order)

Not sold through distributors. Write direct for free engineering data and price list.

TRADE MARK **CURTIS**

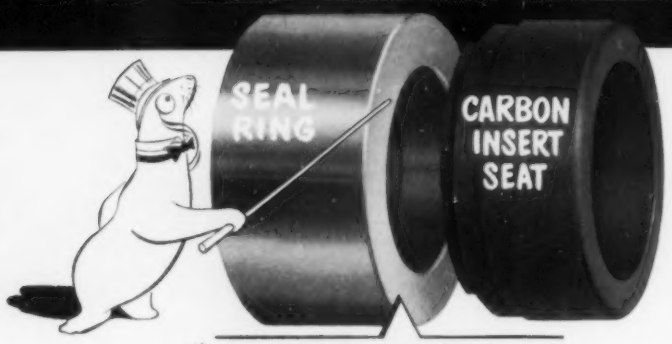
UNIVERSAL JOINT CO., INC.

11A Birnie Avenue, Springfield, Mass.

As near to you as your telephone

EXCLUSIVELY A MANUFACTURER OF UNIVERSAL JOINTS SINCE 1919

#55 FACED MECHANICAL SEALS RESIST WEAR AND CORROSION



#55 FACING MATERIAL

THIS BULLETIN TELLS THE STORY

. . . For further details write today for a copy of Bulletin No. 469-PG.

•

**ROKIDE Process Coating developed by the Norton Co. of Worcester, Mass.*

A new and superior facing material is now available on the engineered mechanical DURA SEAL. #55 faced seal rings are long-wearing, operate at extremely high or low temperatures, and present highest resistance to wear and corrosion. #55 Facing Material combines the low-friction benefits of ceramic materials with the strength and resistance of alloyed steels.

DURAMETALLIC CORPORATION

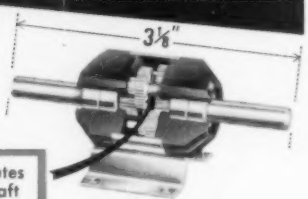
The Perfect Seal

KALAMAZOO MICHIGAN

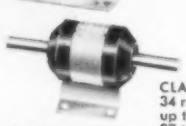
CIRCLE 155 READER SERVICE CARD

Metron *Anti-Backlash* SPEED REDUCERS

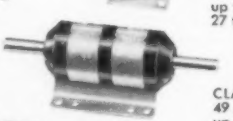
- Small in size
- Ready-to-go in your product
- Quick delivery



- Backlash only 15 minutes or less at lowspeed shaft
- Speeds up to 10,000 rpm at highspeed shaft
- Up to .013 HP at lowspeed shaft



CLASS A—34 ratios up to 27 to 1



CLASS B—49 ratios up to 729 to 1

CLASS C—122 ratios up to 19,683 to 1

CLASS D—232 ratios up to 531,441 to 1 (not shown)

Save on your design, production, and assembly costs by ordering these ready-to-go miniature components for your product.

WRITE for Bulletin #100

Metron INSTRUMENT COMPANY

444 Lincoln St., Denver 3, Colo.

DISTRICT OFFICES • NEW YORK • CHICAGO

CIRCLE 154 READER SERVICE CARD

CIRCLE 156 READER SERVICE CARD

mits ganging any number of potentiometers. Made to customer specifications. Wire-wound, double wiper unit is said to be first of its size to achieve so close a tolerance and so high a resistance. **Micro-Lectric Div., Micro Machine Works, Inc., 19 Debevoise Ave., Roosevelt, N. Y.**

Circle 18, inside back cover

Foot-mounted valves . . .

are suited for hazardous locations and wherever remote pilot operation is desired on pneumatically-interlocked circuitry. The ¼-in. four-way valves are offered in single and double types. Can be controlled electrically or pneumatically or mechanically-actuated. Bodies are Navy M bronze, stem is hard-chrome plated stainless steel with standard O-ring packings. No springs are used. Single type valves are for 35 to 250 psi air and oil service. Double types control 35 to 250 psi air and oil, as well as vacuum down to 1 in. Hg less than absolute. Offered for immediate delivery from local stock. **Valvair Corp., 454 Morgan Ave., Akron 11.**

Circle 19, inside back cover

Foot-operated poppet valves . . .

in two and three-way models have air flow capacity of 75 cfm at 100 psi. Valves are surface mounted, packed complete with foot pedal. Spring action closes valves on release of pedal. Parts are positioned at right angles in brass body with heavy lugs for two-bolt mounting. Two-way valve has ¾-in. NPT parts, designed for use in limited space. Three-way valves are similar except for replacement parts. **A. Schrader's Son, Div. Scovill Mfg. Co., 470 Vanderbilt Ave., Brooklyn, N. Y.**

Circle 20, inside back cover

Adjustable-speed drive . . .

is available at present in ratings of 10 to 200 hp. Operates from standard 440-v, three-phase, 60 cps industrial power. Package drive consists of an amplistat controller, a standard dc shunt-wound drive motor and remote control station. Units operate over a speed range of 10:1 with constant-torque load. Drive is capable of operation at 150% overload for 1 min

(Continued on page 102)

ROCKFORD

MORLIFE® CLUTCHES

Help Heavy-Duty Tractors Keep "Busy at Both Ends"

Because ROCKFORD Morlife® CLUTCHES provide 100% more torque grip than previous type clutches of equal size, they help road machines do double duty. Easier operation is accomplished by reducing the required engaging pressure. 50% better heat disposal avoids down-time caused by burned or warped plates. Numerous maintenance records prove that MORLIFE clutches operate four to ten times as long without adjustment or plate replacement. Let this NEW type clutch help keep your heavy-duty machines ON the job and OUT of the shop.

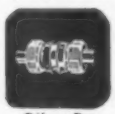
SEND FOR THIS HANDY BULLETIN

Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

Small Spring Loaded

Automotive Spring Loaded

Heavy Duty Spring Loaded


Oil or Dry Multiple Disc

Heavy Duty Over Center

Light Over Center

Power Take-Offs

Speed Reducers

ROCKFORD CLUTCH DIVISION BORG-WARNER

209 Catherine St., Rockford, Ill., U.S.A.

Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

ROCKFORD B-W BORG-WARNER

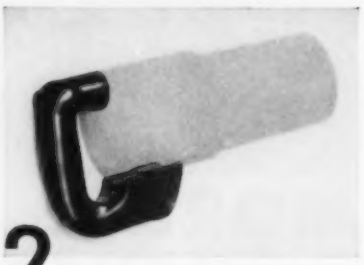
CLUTCHES

Six Standard Design Problems . . .

and how to solve them with URETHANE rubber

1. Production Cost:

Hard-wearing urethane rubber is easily cast; requires no post-finishing. *Example:* A cast urethane rubber pin and ball joint replaced machined steel in this gear shift linkage part, reducing finished-piece cost of assembly by *80 per cent!* Other advantages: Self-lubricating, vibration dampening.



2. Vibration Dampening:

Dimensional stability and high durometer hardness make urethane rubber an ideal choice for parts subjected to shock, impact and vibration. *Example:* Handle for pneumatic hammer reduces operator fatigue and injury risk; improves guidance control. Other benefits: non-slip grip and wearability.

3. Maintenance Cost:

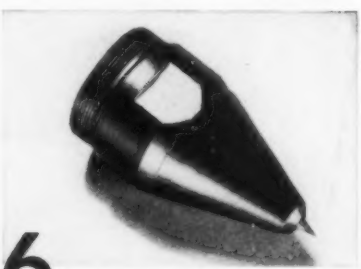
Urethane rubber is grease and oil resistant. Self-lubricating properties may be imparted, cutting maintenance costs on heavy equipment by as much as one-third. *Example:* Socket and coupling for heavy-duty ball-joint assembly. Other benefits: Lower assembly cost, no machining, vibration dampening.

4. Noise Reduction:

Urethane rubber parts cushion while they work; completely eliminate gear noise. *Example:* Sprocket gear for a chain-driven motor bike silenced chain whine, showed no significant wear after 62,000 miles of operation. Other benefits: Lowers chain wear, maintenance costs.

5. Misalignment Stress:

Elasticity of urethane rubber permits up to 0.040 inches linear and 12° angular misalignment without malfunction of meshed parts. *Example:* This urethane rubber drive coupling replaces a laminated metal unit; has sufficient strength to transmit high horse power in rapid stop-and-go operation.



6. Abrasion Resistance:

Very high abrasion resistance enables urethane rubber to outwear ordinary rubbers by 8 to 10 times, and even steel parts in some uses. *Example:* This cast urethane rubber nozzle for sand blasting equipment replaces an all-metal nozzle; wears longer, weighs and costs less.

Other design problems requiring special properties of hardness; tensile, elongation and tear strength; rebound elasticity, high and low temperature strength, solvent and oxygen resistance, good electrical and mechanical properties, are being solved with urethane rubber. Write today for technical data, test studies and sources of fabricating assistance.

MOBAY

First in Urethane Chemistry

Mobay supplies basic chemicals and technology required for the manufacture of urethane rubber—latest addition to the growing list of urethane products for industry.

MOBAY CHEMICAL COMPANY

Dept. P-10
1815 Washington Road
Pittsburgh 34, Pa.

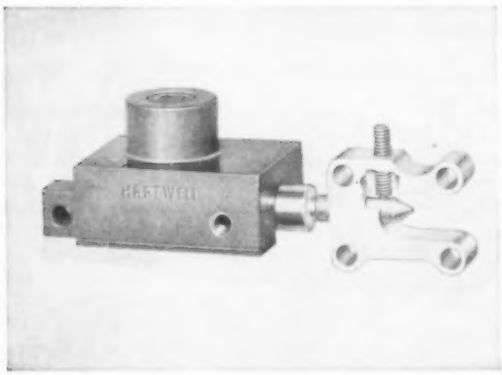
Practical Design Tips

No. 3 of a series

Perhaps the applications shown below will suggest ways you can profit from the use of Vlier tools. Many companies have simplified product design—with resultant savings—by substituting these simple, off-the-shelf items for complicated custom devices.

TO LIMIT TORQUE APPLIED TO SOCKET SET SCREWS grind the screw end of a Vlier Torque Thumb Screw to the proper size hex. The amount of torque can be quickly adjusted between 10 lbs. and 125 lbs. Once set torque is reached, knurled ring spins freely, preventing overtightening. Backing off is positive.

TO SECURE THE DUPLICATOR CARRIAGE of this metal fabricating machine when not in use, the manufacturer uses two Vlier Swivel-Pad Torque Thumb Screws. These simple holding tools with the unique ball-joint pad construction, limit the amount of torque which can be applied, and prevent scoring or damage to the ways. Vlier Swivel-Pad Torque Thumb Screws such as used in this application are available in various sizes and end pressures.



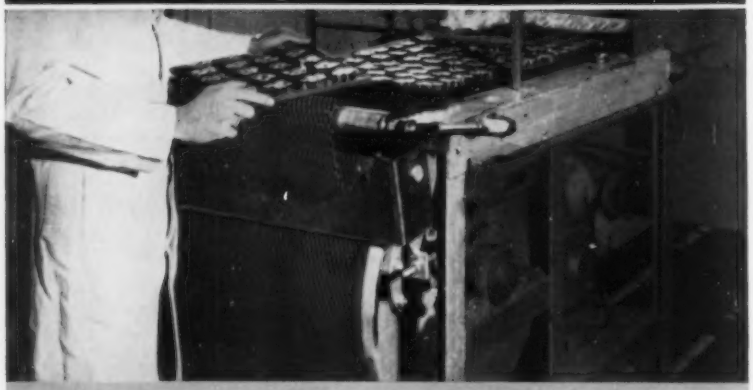
TO PROPERLY POSITION THIS YOKE-SHAPED PART for entrance into a latch assembly, a Vlier S-58 Spring Plunger is used. The threaded stud, extending horizontally, is slotted on two sides. As the stud is rotated, the spring plunger snaps into the slot assuring the proper position of the yoke. Vlier Spring Plungers are available in six nose types; various end pressures.

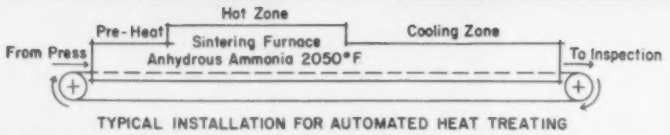
NEW 1958 CATALOG NOW AVAILABLE—Eight pages; completely revised. Includes information and specifications on all new Vlier products, including the Torque Handle, Stock Pusher, Leveling Pad. Makes ordering easy. Suggests new uses for these proven time-savers. Write for your copy today!

VLIER
Engineering Corporation
A subsidiary of Barry Controls, Inc.
8900 Santa Monica Blvd. • Los Angeles 46, California

CIRCLE 159 READER SERVICE CARD

Cambridge WOVEN WIRE BELTS





TYPICAL INSTALLATION FOR AUTOMATED HEAT TREATING

METAL-MESH BELTS CUT COSTS, INCREASE PRODUCTION IN CONTINUOUS PROCESSING

Continuous movement of metal parts, foods, chemical or ceramic products through practically any type of processing operation eliminates batch processing and manual handling for faster, more economical, more uniform production. Through wet, cold, hot or dry operations, Cambridge Belts give you all these advantages:

ALL-METAL CONSTRUCTION IS HEATPROOF, COLDPROOF, RUSTPROOF—Cambridge Belts can be woven from any metal or alloy, thus can be made impervious to damage from temperatures from sub-zero up to 2100° F., water, acids or caustic solutions.

OPEN MESH PROVIDES FREE CIRCULATION—process atmospheres pass freely through the belt for uniform processing of the parts in the load, process solutions drain through the mesh in a flash.

WOVEN WIRE CONSTRUCTION—has no seams, lacers or fasteners to wear or break—reduces maintenance costs and eliminates frequent belt replacements.

SPECIAL SURFACE ATTACHMENTS AVAILABLE—raised edges or cross flights to hold product on belt during movement.

Whether you design machinery for your own use or for resale, your Cambridge FIELD ENGINEER can explain how the many advantages of Cambridge belts make automated processing practical and economical. And, he'll recommend the belt size, mesh or weave—in the metal or alloy—best suited to your operation. Call now. He's listed in the classified phone book under the heading "BELTING, MECHANICAL". Or, write for FREE 130-PAGE REFERENCE MANUAL giving mesh specifications, design information and metallurgical data.

The Cambridge Wire Cloth Co.

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

Department P, Cambridge 8, Maryland

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

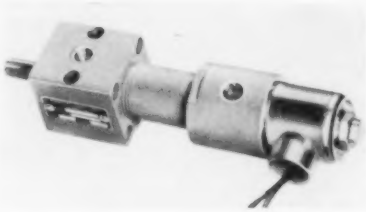
or at 250% overload for 10 sec. Motor is protected against overload and line for short circuit. All control units are isolated from power unit and electrically isolated from line. Drive functions are controlled from a portable station that includes a speed-adjusting potentiometer. **General Electric Co., Schenectady 5.**

Circle 21, inside back cover

High-temperature switch . . .

is a miniature unit that operates in temperatures from —300 to 500 F. Withstands shock of 40 to 50 G at vibrations of 50 to 2000 cps. Switch is housed in a glass bonded mica case that incorporates a glass plunger that permits switch to withstand severe humidity and temperature variations. Dimensions are 1¼ x ⅜ x ⅜ in. high. Utilizes leaf and roller actuators. **Meletron Corp., 950 N. Highland Ave., Los Angeles 38.**

Circle 22, inside back cover



Valve-operated cylinders . . .

combine a single-acting cylinder with a three-way solenoid valve. Resulting integral power unit requires one air connection, which can be made with flexible hose. Offered in bore sizes of 1, 1⅛, 1½, 2, 2½ and 3 in. in any stroke length from ⅛ in. up. Unit is for pressures from 0 to 200 psi. Most ac and dc voltages are available. Two standard mountings through rod end are front face-mounted or foot-mounted with ¼-20 sockethead cap screws. Foot, limit or hand switches may be used. Valve and cylinder combinations are said to withstand 20 million cycles of operation without breakdown. **Airmatic Valve, Inc., 7313 Associate Ave., Cleveland 9.**

Circle 23, inside back cover

High-pressure valves . . .

for hydraulic or cold raw water service have valve seats that are integral with replaceable hardened stainless steel sleeve. Commercial standard O-rings in molded Teflon backups provide a flexible seal between sleeve and valve body. Said to give shockless performance and leakfree shutoff, unaffected by minute deflections or breathing of valve body under high pressure, hydraulic shock or pressure surges in the lines. Diaphragm-operated valves

(Continued on page 106)

Now...from Morse Chain

New Nylon Couplings

Cost 20% less, need no lubrication, last indefinitely!

New Morse Nylon Flexible Couplings cost less to buy and maintain than steel couplings. They use economical, stock roller chain sprockets—need no protective cover. They last longer, too . . . operate without lubrication because friction and wear are negligible.

Order complete couplings—½" pitch links plus stock sprockets (plain, finished bore, or taper-lock)—or buy just the links and use your own sprockets. Morse Nylon Couplings, made of Du Pont "Zytel" resin, are ideal for loads from fractional to 40 h.p. and speeds from 500 to 5000 rpm. And they adjust to misalignment.

For facts on Nylon Couplings, or the other couplings in the most complete line ever offered, call your local Morse Distributor. He's listed in the Yellow Pages under "Power Transmission". Or write: MORSE CHAIN COMPANY, DEPT. 4-38, ITHACA, NEW YORK. Export Sales: Borg-Warner International, Chicago 3, Illinois.

IN POWER TRANSMISSION
THE TOUGH JOBS COME TO

MORSE

MORSE B-W

*Trademark

REMEMBER: Only Morse offers all four flexible couplings: Chain, Morflex and Radial, Morflex and Radial Driveshafts, and Nylon

★ Useful though uncommon

★ Easy to cut

Tapered gears, although not commonly used, offer a number of advantages when you have a design problem requiring an angular relationship between gear shafts. Production is no problem because, with the proper fixtures, tapered gears can be cut rapidly and economically on a Fellows Gear Shaper.

The tapered gear is simply one whose axis is at an angle to that of the conventional spur or helical gear with which it meshes. If the two axes are at right angles, the "tapered" gear becomes a face gear. If the axes are parallel, it is an ordinary cylindrical gear.

As a result of the use of tapered gears in an aircraft engine, an article giving basic formulae and design considerations was written by a Fellows engineer and published in 1948. Increased interest in this type of gear has since resulted in a number of other applications in machine tools, marine drives, speed reducers and missile projectors.

Because of this increased interest, reprints of the article, "Designing Tapered Gears," are being made available. If you would like a copy, simply write to our main plant in Springfield, Vermont.

THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont
Branch Offices:
1048 North Woodward Ave., Royal Oak, Mich.
150 West Pleasant Ave., Maywood, N. J.
5835 West North Avenue, Chicago 39
6214 West Manchester Ave., Los Angeles 45

THE PRECISION LINE *Fellows* *Gear Production Equipment*

With this **new** socket head cap screw you can Pre-Load without indentation!

the new P-K® PRE-LODE

Now . . . Parker-Kalon's new PRE-LODE Socket Head Cap Screw gives you *greater bearing surface under the head than ever before!* With this new head, a research achievement resulting from the combined efforts of the Socket Screw Manufacturers' Technical Committee, you can now apply higher torque . . . pre-load the fastener for maximum holding power without danger of marring or indenting softer materials in which the screw engages. This means greater load carrying capacity and better functioning in holes having a greater body clearance. P-K's PRE-LODE Socket Head Cap Screws are designed for high tightening. In many cases, the socket has been enlarged to allow more wrenching area. Standard sizes ¼" to 1" PRE-LODE Socket Head Cap Screws are *Size-Marked* for easy identification, and are manufactured to exacting specifications. Available now from your authorized P-K distributor at no increase in cost. Write today for complete technical data and samples.

Sold Everywhere Through Leading Industrial Supply Distributors.

PARKER-KALON® *PRE-LODE Socket Head Cap Screws*

PARKER-KALON DIVISION, General American Transportation Corporation, Clifton, New Jersey.

Only Parker-Kalon offers both PRE-LODE and SIZE-MARK in Socket Head Cap Screws

New Designs in Motors from HOLTZER-CABOT

VARIABLE SPEED SUB-FRACTIONAL DC MOTOR

This new motor—Model RBD-25—is available in two standard units: RBD-2505 with a rating of 0.5 oz. inches; and RBD-2510, rating 01.0 oz. inches. Both operate at speeds up to 1800 RPM with input of 24 to 115 V. D. C. This is a shunt wound motor and speed can be varied by changing armature voltage.

2-SPEED REVERSIBLE SUB-FRACTIONAL AC MOTOR

Model RBC-2514. Available with basic speeds of 1800 RPM and 3600 RPM and with standard gear reductions from 3:1 to 3600:1. Basic torque ratings for continuous duty at 115 volts, 60-cycles; 3600 RPM synchronous range from 0.15 to 0.5 oz. inches.

SYSTEMS DEVELOPMENT MOTOR KIT

Designed primarily for research laboratories and engineering departments, this kit makes it possible to determine the proper servo, torque or synchronous motor required for instrumentation and automation applications. Eliminates the need for purchasing sample motors for testing. Contains all the necessary motors and components to assemble—with bench tools only—32 different motors.

For more information, write, or use Readers' Service Card.

Sales—Service Representatives in Principal Cities throughout the World

HOLTZER-CABOT MOTOR DIVISION
NATIONAL PNEUMATIC CO., INC.
125 Amory Street, Boston, Massachusetts

Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems

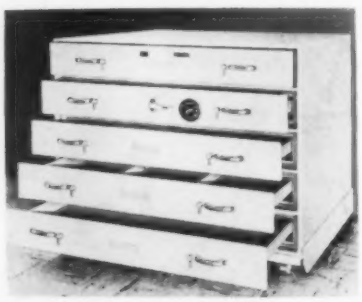
are available in sizes to 3 in. NPT for 4000 psi service and to 2 in. NPT for 6000 psi, two or three-way, NO or NC. **Sinclair-Collins Valve Co., 454 Morgan Ave., Akron 11.**

Circle 24, inside back cover

Miniature thermal relief valve . . .

relieves excess pressures caused by thermal expansion of fluids in a closed system. Standard valve is reported to have no internal leakage at 20 psi. External leakage is zero at all pressures. Cracking pressure is 30 (±4) psi. Capacity is 3.5 gpm. Operates in temperatures of −65 to 280 F. The leakproof unit weighs under 1 oz. **Fluid Regulators Corp., 313 Gillette St., Painesville, Ohio.**

Circle 25, inside back cover



Fireproof file . . .

for drawings as large as 31 x 42 in. is equipped with a key lock at the handle and a drill-proof steel plate in front of locking mechanism. Also available is either a combination lock or a manipulation-proof combination lock. Meets U. S. Government security requirements. Weighs about 1500 lb. Unit is supplied with ball bearing casters, which can be removed for file stacking. **Chas. Bruning Co., Inc., 1800 Central Rd., Mt. Prospect, Ill.**

Circle 26, inside back cover

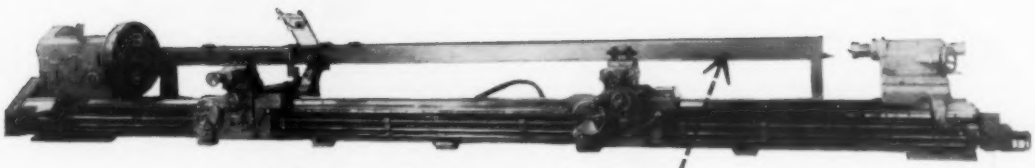
Semi-automatic whiteprinter

is a full-width, dry process unit that prints and develops at speeds up to 20 ft/min. Accommodates prints to 45 in. wide. It will reproduce, in cut sheets or rolls, anything typed, written, drawn or photographed on reasonably translucent material. Finished prints are delivered in original sequence, dry and ready for immediate use. Unit is equipped with a 2000-w printing lamp, a ribbed rubber sealing sleeve to convey prints through the developer, an adjustable print tray. Floor model is $1495, FOB Chicago. **C. F. Pease Co., 3816 N. Rockwell St., Chicago 18.**

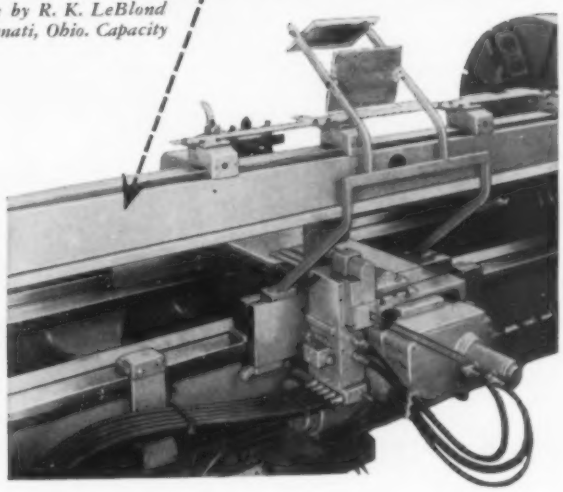
Circle 27, inside back cover

Weldynamics

ARC WELDING AT WORK CUTTING COSTS



Duplicating lathe made by R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Capacity 37' between centers.



Planning for profit demands designing for lower cost

WELDYNAMICS lets you use steel and save. For example, because this lathe template rail is made of welded steel, it is 24% more rigid, weighs 54.6% less, and costs a third less than its cast counterpart. It was also simpler to design, and easier to fabricate and machine.

How you can use Weldynamics

Lincoln men, expert in Weldynamics, will help you. They offer the best in technical advice on design, procedures, equipment and electrodes.

Write for "Design Ideas", tips on designing for welded steel, sent at no cost to designers.

The World's Largest Manufacturer of Arc Welding Equipment

LINCOLN

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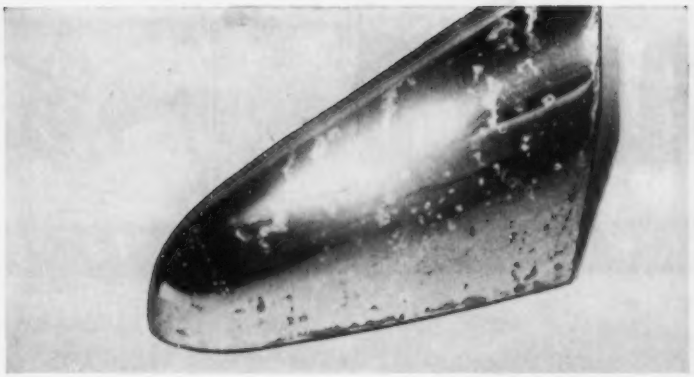
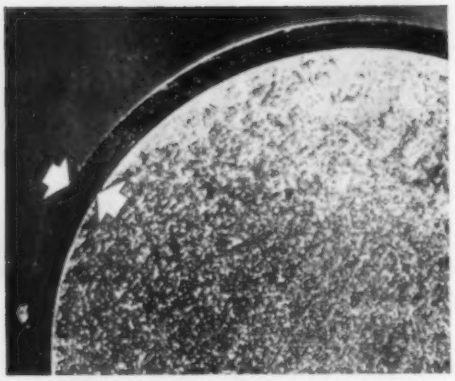
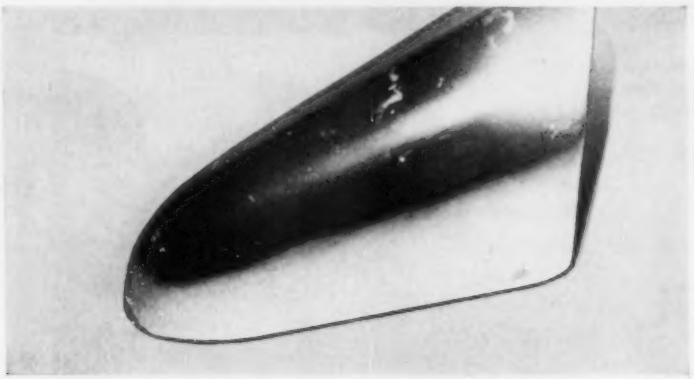
THE LINCOLN ELECTRIC COMPANY, DEPT. 1329, CLEVELAND 17, OHIO

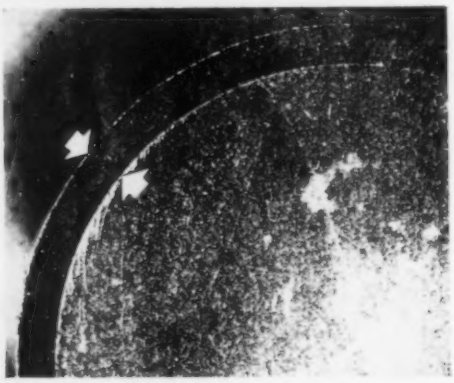


UNICHROME BRIGHT CRACK-FREE CHROMIUM MADE THIS DIFFERENCE IN PROTECTION. Photographs show results of 72 hour acetic acid salt spray test. Part at top was plated with ordinary chromium according to automotive manufacturer's specifications for copper, nickel, chromium finishing. Part at bottom had same copper and nickel deposits but Unichrome Crack-Free Chromium replaced the ordinary chromium, thus greatly increasing corrosion resistance.



UNICHROME SRHS® CHROMIUM MADE THIS DIFFERENCE IN THICKNESS. Enlarged cross sections of identical steel rods show ratio of thickness of plate from ordinary chromium solution (top) to thickness from SRHS Chromium Solution (bottom) . . . a much thicker deposit in the same plating time!





How to get more corrosion resistance from chromium plate

When consumers find fault with decorative chromium plate, it's generally due to early corrosion.

This trouble starts with pores and cracks that occur in all ordinary chromium in the range of thicknesses generally used for decorative plating. Road chemicals, salt atmosphere and fumes find a path right down to base metal. Corrosion starts. As corrosion increases, finish failure progresses, allowing still more corrosion.

But you can stop this at the source.

THICKER, CRACK-FREE CHROMIUM

Chromium itself is passive. It doesn't corrode. Eliminate pores and overcome its cracking and you greatly improve its corrosion *protection*. Pores are eliminated by thicker plating. To overcome cracking, use the Unichrome Bright *Crack-Free* Chromium Process. This deposit is free from corrosion-admitting cracks. It has already been used in automotive production for a year.

MINIMIZE PRODUCTION PROBLEMS

Unichrome *Crack-Free* Chromium is far superior to ordinary chromium not only in protection, but also in operating advantages. The solution is self-regulating. It offers improved throwing power, also better coverage — even over passive nickel.

TO PLATE THICKER CHROMIUM

For those who desire thicker deposits but do not require freedom from cracking, other Unichrome self-regulating processes offer distinct advantages. They plate up to 80% faster than ordinary chromium plating processes. They cover parts with less dulling or burning, are less susceptible to clouding due to current interruption. Control is simplified by their self-regulating features.

Whichever process is best for your products, Metal & Thermit has over 30 years of service experience to help you make it work. Call in an M&T plating engineer to survey your requirements, tell you what's needed for the results you want. Or, send for Bulletins.

METAL & THERMIT
CORPORATION
GENERAL OFFICES: RAHWAY, NEW JERSEY
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CIRCLE 167 READER SERVICE CARD →

highest

CATALOGS

production shutdowns **cost more than motors!**

dependable U.S. motors *prevent shutdowns!*

...it pays to specify

U.S. Uniclosed Motors

Because production shutdowns *cost far more than motors,* real economy lies in buying motors of *quality* you can depend on! U.S. UNICLOSED is the motor choice for normal production needs. U.S. UNICLOSED MOTORS give you the quality and dependability that are built into every U.S. motor—plus protection *far* superior to ordinary dripproof motors. Only U.S. protects all windings with nature's non-organic, non-carbonizing insulation—asbestos! This prevents costly burn-outs. Unlike ordinary makes, U.S. motors have shock-resistant, corrosion-resistant cast iron frames that are *normalized*—heat-seasoned to prevent warp! To protect bearings, U.S. LUBRIFLUSH transverse lubrication purges old grease. This minimizes lubrication and maintenance requirements. These and many other factors add up to U.S. *quality*—the kind you can depend upon to keep production lines running! U.S. UNICLOSED 3-phase AC motors are available in RATINGS ¼ to 250 H.P. It pays to specify: "U.S. MOTORS."

U.S. ELECTRICAL MOTORS INC.

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OR MILFORD, CONNECTICUT

FREE COLOR-ILLUSTRATED BROCHURE
For detailed data on Uniclosed Motors, write for Uniclosed Bulletin No. F-1856

highest performance at utility prices!

DECCTO COUPLER

only $4.25 for the highest performing ball-check coupler available.

The "DECCTO" Quick Disconnect Coupler . . .

gives you these advantages:

- Outstanding flow and seal characteristics
- Smooth, firm, quick-coupling action
- Easy connecting and disconnecting under pressure
- Positive seal with rapid valve shut-off
- Complete inter-changeability with similar components
- Immediately available from stock

For original equipment or replacement parts on agricultural and industrial equipment, specify Bruning's DECCTO Coupler.

Bruning has a complete line of high performance hydraulic and pneumatic couplers, cylinders and valves.

WRITE FOR FREE BULLETIN NO. 561-1-A.

THE BRUNING COMPANY

611 So. 9th St., Lincoln, Nebraska

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 114.

PLANNED LUBRICATION—Bulletin BK-19-a, 20 pp. Lists lubricants for specific types of equipment operating under normal conditions of speed and temperatures. Also, shows how most requirements can be met with minimum number of lubricant types and densities. Includes benefits, uses, characteristics, densities, specifications and container sizes of products listed. Keystone Lubricating Co., 3100 N. 21 St., Philadelphia 30.

Circle 28, inside back cover

SELECTING STEAM TRAPS—Engineering manual, 40 pp. Provides a steam trap selection guide, an explanation of four basic types of traps and their functions, how to size a steam trap, a table of factors and instructions on selection of traps for 45 major classes of equipment. Also, catalog information on line of traps and fluid specialties. V. D. Anderson Co., Div. International Basic Economy Corp., 1935 W. 96 St., Cleveland 2.

Circle 29, inside back cover

CASTERS AND WHEELS—Catalog, 44 pp. Specifications, suggested applications, mounting dimensions, capacity ratings; illustrated with photos, sectional views and dimensional drawings. Includes information on custom-built casters. Albion Industries, Inc., Albion, Mich.

Circle 30, inside back cover

VIBRATION MOUNTS—Bulletin 710, 16 pp. Contains engineering data, including tables and transmissibility curves, on design and performance of three types of mountings for both high and low temperatures. Typical applications are illustrated and uses are discussed. Lord Mfg. Co., 1635 W. 12th St., Erie, Penna.

Circle 31, inside back cover

HYDRAULIC CYLINDERS—Catalog 4, 12 pp. Gives design features, specifications and dimensions of non-rotating, double-acting cylinders. With cutaway views, photos, dimensional drawings. Lynair Inc., 3100 E. Michigan, Jackson, Mich.

Circle 32, inside back cover

DC MINIATURE MOTORS—Catalog, 10 pp. Describes four basic models and sizes. Performance data, specification details and dimensions are given. Globe Industries, Inc., 1784 Stanley Ave., Dayton 4, Ohio.

Circle 33, inside back cover

CORROSION CONTROL—Booklet, 8 pp. Graphically illustrates in-service and laboratory tests conducted with wrought iron and other metals. Describes one type of wrought iron and how its corrosion resistance was increased. A. M. Byers Co., P. O. Box 1076, Pittsburgh 30.

Circle 34, inside back cover

DRAFTING TEMPLETS—Catalog 58, 8 pp. Size, scale, description and uses, as well as price, are shown for each of 28 templets and sets. Timely Products Co., Box 416, Basil, Ohio.

Circle 35, inside back cover

ADJUSTABLE-SPEED DRIVES—Brochures EN-64 and EN-65, 12 pp each. Covers dc drives from 1 to 40 hp that use electronic tubes for power conversion (EN-64); sizes 1 to 200 hp that use magnetic amplifiers for power conversion (EN-65). With photos, schematics, line drawings. Cutler-Hammer, Inc., 296 N. 12 St., Milwaukee 1.

Circle 36, inside back cover

TORQUE VS RPM—Chart. Tabulates oz-in. torque vs rpm at stated horsepower. Engineering data ranges from 1/2000 to 4 hp and from 1 to 14,000 rpm. John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wis.

Circle 37, inside back cover

CONTINUOUS STRIP ELECTRICAL TERMINALS—Booklet, 16 pp. Describes available strip terminals and includes dimensional carts to help selection. Kent Mfg. Corp., Newton, Mass.

Circle 38, inside back cover

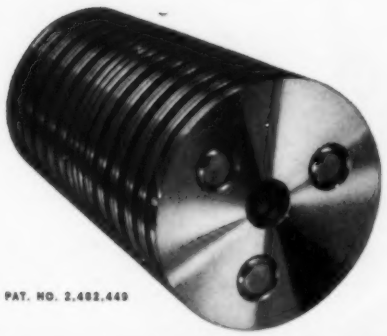
HYDRAULIC CYLINDERS, 2000 to 3000 PSI—Bulletin H-100, 8 pp. Describes design, construction and operation supplemented by cutaway view. Mounting data and sketches are included. Milwaukee Cylinder Co., 5757 S. Pennsylvania Ave., Cudahy 7, Wis.

Circle 39, inside back cover

EXTERNAL COTTERS—Data Sheet 301-EC, 1 pp. Describes 15 standard cotters, with dimensions and prices. Dimensions include wire size, pin dia and length. With dimensional drawings. Hunter Spring Co., 1 Spring Ave., Lansdale, Penna.

Circle 40, inside back cover

(Continued on page 114)



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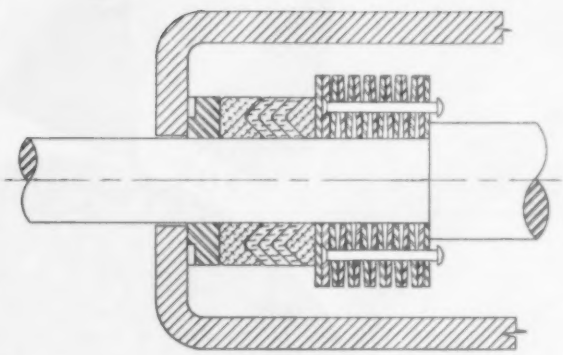
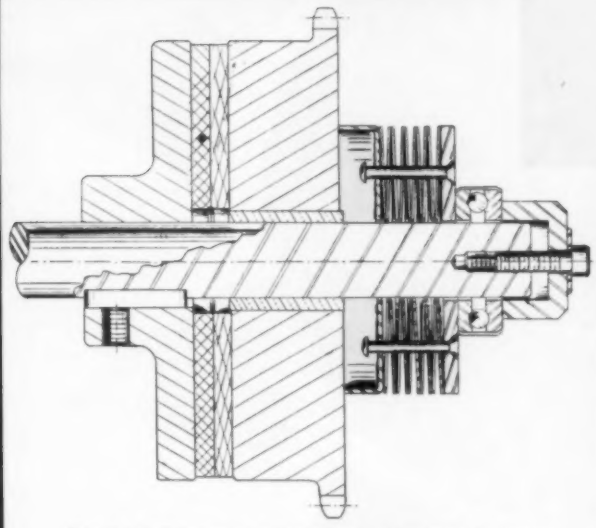


Typical installation of a "cartridge" of multiple Belleville washers in a shaft seal.



Typical installation of a "cartridge" of multiple Belleville washers in a clutch, such as in a machine tool drive.

Some uses of Belleville Washers as a spring ENERGY CARTRIDGE

Where loads are high, operating space limited, and conventional spring forms fail to qualify, Belleville washers in the form of an Energy Cartridge can be a welcome solution. Two such conditions are illustrated here.

By preassembling the washers in a single compact unit held together by pins or posts, installation is simplified and error is prevented in stacking loose washers in sequence. For varying loads, many combinations are available: in series, parallel or parallel series.

Belleville washers may be used for vibration isolation, as spring mountings for punch and impact presses, or to maintain constant pressure. For further information, write for pamphlets "Belleville Springs" and "Energy Cartridge." For engineering and production assistance on large or small requirements, contact the nearest A.S.C. Division listed below.

Associated Spring Corporation

General Offices: Bristol, Connecticut

Wallace Barnes Division, Bristol, Conn. and Syracuse, N. Y.
B-G-R Division, Plymouth and Ann Arbor, Mich.
Gibson Division, Chicago 14, Ill.
Milwaukee Division, Milwaukee, Wis.
Raymond Manufacturing Division, Corry, Penna.
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San Francisco Sales Office, Saratoga, Calif.
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Cleveland Sales Office, Cleveland, Ohio
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Canadian Subsidiary: The Wallace Barnes Co., Ltd., Hamilton, Ontario and Montreal, Quebec

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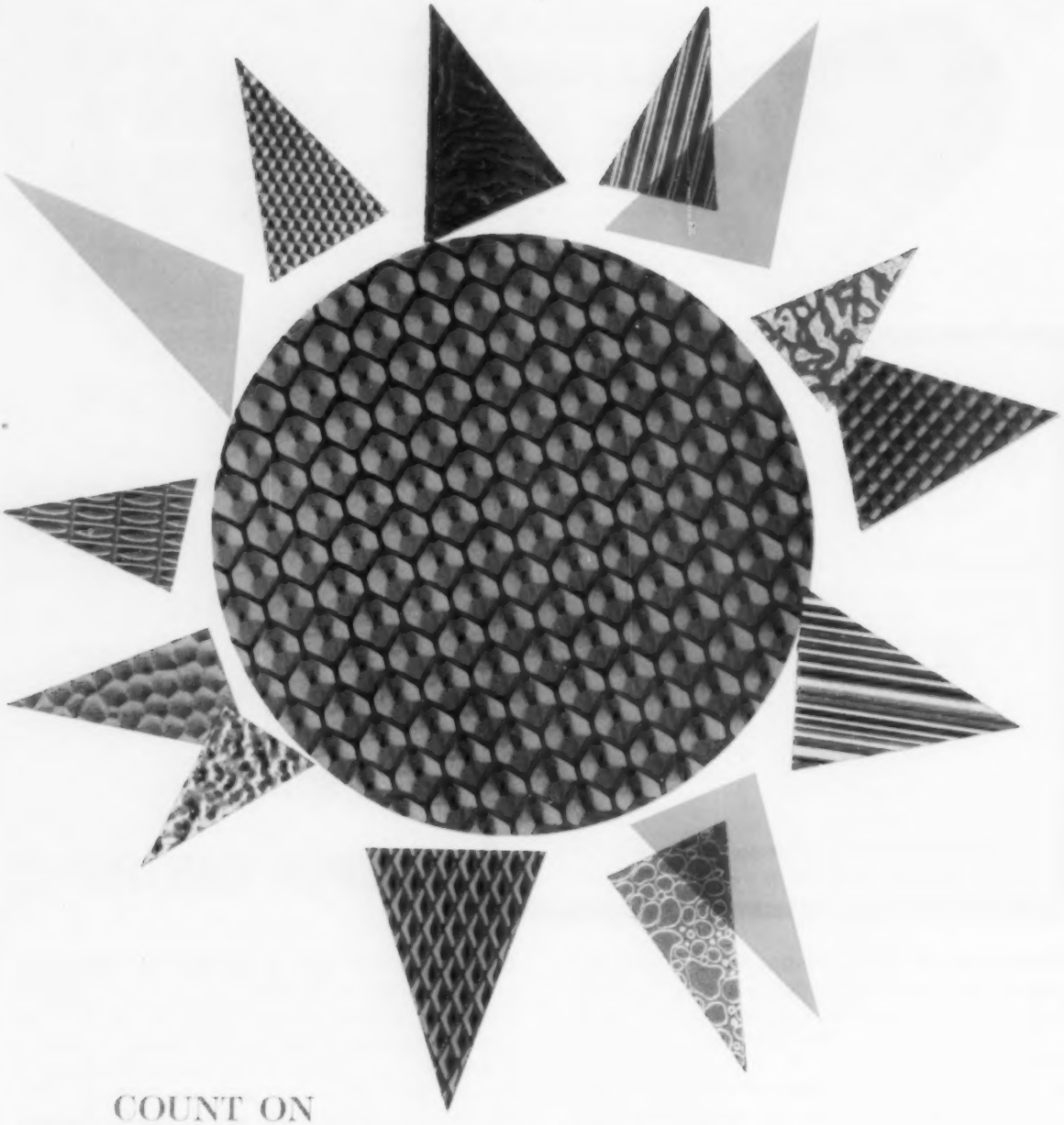


COUNT ON

FIRESTONE FASHIONIZED ALUMINUM

FOR YOUR BIG ANSWERS

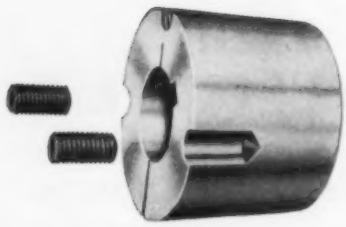
IN BRIGHTWORK!

Count on Firestone's king-sized capacity for mass producing colorful low-cost parts and trim for automotive products and home appliances.

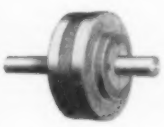
Whether you need big trim, small trim, or a lot of both—you need Firestone Fashionized Aluminum. You need the kind of equipment and experience that only Firestone and its streamlined new facilities can offer: the all-inclusive press sizes and capacities, the automatic transfer equipment and high-speed conveyors, the anodizing line that delivers 5,000 square feet of colored brightwork an hour —in part sizes up to seven feet long! In short, you should look into Fashionized Aluminum and Firestone's 50 years of experience in metal fabrication and finishing. Write, phone or wire today.

FIRESTONE FASHIONIZED ALUMINUM

FIRESTONE STEEL PRODUCTS COMPANY, AKRON 1, OHIO



TAPER-LOCK Bushings are *Interchangeable!*

Change from shaft to shaft				
Change from size to size				
Change from sheaves to sprockets to couplings to conveyor pulleys				

Save Time!

There's nothing like Taper-Lock for mounting wheels on shafts! First, you get off-the-shelf convenience. No reboring, no machining, no waiting!

Save Work!

You get the holding power of a shrunk-on fit with minimum effort. Product and bushing slip on the shaft as a unit. Tighten the screws—and you're set!

Save Money!

You save big money by minimizing down-time with *quick* changes. And interchangeability minimizes inventory. Note that all of the above installations are handled with a total of only four bushings—all with the same outside diameter!

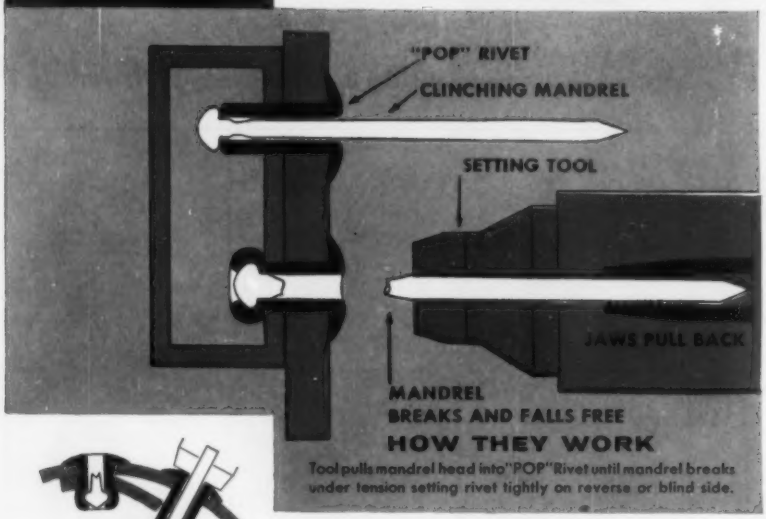
DODGE MANUFACTURING CORPORATION, 1200 Union St., Mishawaka, Ind.

DODGE
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the *white* pages of your telephone directory for "Dodge Transmissioneer".

5-Year Study Proves

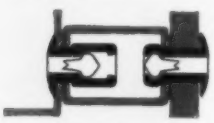
Each "POP" RIVET Saves 4.9¢ on Installed Costs



HOW THEY WORK

Tool pulls mandrel head into "POP" Rivet until mandrel breaks under tension setting rivet tightly on reverse or blind side.

High Clinching Action
Pulls parts together with up to 600 lbs. squeeze. Eliminates need to clamp.



Wide Grip Range
Simplifies inventory, purchasing, inspection. Same length "POP" Rivet holds tight through thick or thin.

Vibration Proof
"POP" Rivets cannot back out or become loose. Ensures tight assembly for years of use.

Least Back-Up Space
Strong, high strength "POP" Rivets need only enough back-up space to provide room for set head. Gives more compact design.

Saves 4.9¢ each over other blind rivets

Saves 1.8¢ each over solid rivets

Replace 100,000 solid rivets with strong, high clinch "POP"® Rivets and you save $1,800. Use 100,000 time-tested "POP" Rivets for blind assembly work and you save $4,900.

No other rivet equals the savings potential in *installed costs* provided by "POP" Rivets. The Martin Company saved $223,000 on one fifty-plane contract alone — and with today's rapidly increasing costs, even greater savings are possible. In addition, the extraordinary design flexibility of these rivets gives engineers many opportunities for simplified product design.

Extreme light weight, high production gun — only 2 lb., 3 oz. sharply reduces operator fatigue. Means more rivets set per hour right on the assembly line — rates as high as 1200 per hour even with unskilled operators.

Whether you make planes, missiles, cars, trucks, trailers, metal awnings, furniture, boats, or toys, you can cut costs, simplify design and add assembly convenience with "POP" Rivets. Call or write for our literature now — before you forget. Better still, send a sample assembly for riveting.

UNITED "POP" RIVETS

"POP" RIVET DIVISION
UNITED SHOE MACHINERY CORPORATION
West Medway, Mass. • Phone: Keystone 3-6611

FHP MOTORS—Catalog sheet, 4 pp. Describes and illustrates motors with ratings from 1/2000 to 1 hp; motor parts, motor blowers and gear reduction units. Gives type, dimensions, specifications. Howard Industries, Inc., 1710 State St., Racine, Wis.

Circle 41, inside back cover

COLD-FINISHED BARS—Bulletin 12-5, 4 pp. Revised brochure serves as guide to selection and specification of cold-finished carbon steel bars. Gives mechanical properties, formability, weldability, heat treating, machining, relative cost, shapes and size range. Joseph T. Ryerson & Son, Inc., Box 8000-A, Chicago 80.

Circle 42, inside back cover

VARIABLE DISPLACEMENT PUMP—Bulletin 47550, 4 pp. Specifications and operational characteristics are given, as well as dimensional and mounting data. Oilgear Co., Milwaukee 4.

Circle 43, inside back cover

Letterhead Requests Only

Manufacturers who publish following literature ask that requests for copies be made on company letterheads.

PRESSURIZED AND WATERPROOF CONNECTORS—Catalog, 24 pp. Covers specifications and illustrates MS insert arrangements, receptacles, plugs, caps and cable clamps. H. H. Buggie, Inc., Box 817, Toledo 1, Ohio.

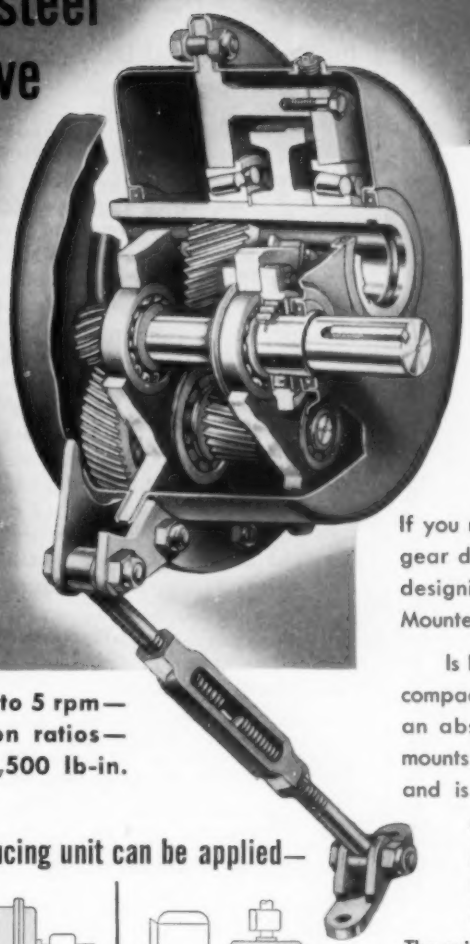
SAMPLING DEVICES—Booklet, 16 pp. Contains more than 35 diagrams and photos to illustrate selection and application of electronic and electromechanical sampling devices. Written by John F. Brinster, authority on data-recording devices and president of this company. General Devices, Inc., P.O. Box 252, Princeton, N. J.

PRODUCTS AND TESTING FACILITIES—Brochure, 24 pp, describes development of mechanical, electronic and photographic systems and a number of components and instruments. Special attention is given to work in hydrogen thyratron and other gaseous conduction tubes and units operating in millimicrosec range. Edgerton, Germeshausen & Grier, Inc., 160 Brookline Ave., Boston 15.

METAL CHARTS—Two charts: one shows melting points of metals, in Fahrenheit and Centigrade scales, ranging from tungsten to mercury; other gives densities of metals, grouped into heavy, medium and light classifications. Charts are colorful and compact. Metals and Fabrication Div., Fansteel Metallurgical Corp., North Chicago, Ill.

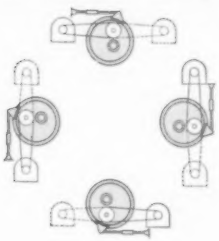
The FALK all-steel Shaft Mounted Drive

- *Versatile*
- *Efficient*
- *Economical*
- *Compact*

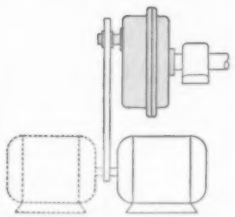


SEVEN SIZES—½ to 50 HP—420 to 5 rpm—single and two double reduction ratios—output torque ratings up to 31,500 lb-in.

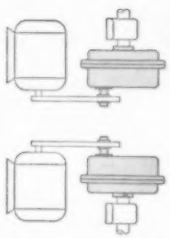
A few of the many ways this reducing unit can be applied—



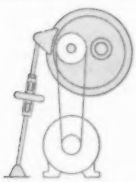
ANY POSITION



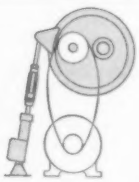
MOTOR EXTENDED
—or below the unit



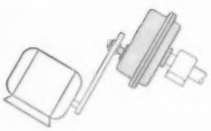
VERTICAL—UP or DOWN



VARIABLE SPEEDS...
through use of variable-pitch sheaves—automatic belt adjustment with tie-rod adjustment



OVERLOAD RELEASE...
that will slacken belts and cut off power if overload occurs



INCLINED SHAFT...
Any standard unit can be mounted in vertical or inclined position by a simple rearrangement of oil drains

THE FALK CORPORATION, 3001 W. CANAL ST., MILWAUKEE 1, WIS.

Representatives and Distributors in Most Principal Cities

Manufacturers of

- Motoreducers
- Speed Reducers
- Flexible Couplings
- Shaft Mounted Drives
- High Speed Drives
- Special Gear Drives
- Single Helical Gears
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To Design men:

If you need an efficient, economical gear drive for the machine you are designing, the all-steel FALK Shaft Mounted Drive is your answer.

Is limited space a problem? This compact speed-reducing unit requires an absolute minimum of space. It mounts directly onto the driven shaft, and is driven through a V-belt or chain from any convenient power source. Unit can be positioned in countless ways, some of which are sketched below. The widest choice of output speeds is made possible by varying driving sheaves or sprockets.

Designed and geared by FALK, recognized leader in gear manufacture, this Shaft Mounted Drive will be a dependable component of your machine.

★

FALK Shaft Mounted Drives are available from factory stocks *from coast to coast.* See your Falk Representative—or write direct for copy of **Bulletin 7100.**

FALK
...a good name in industry

GENERAL INDUSTRIES

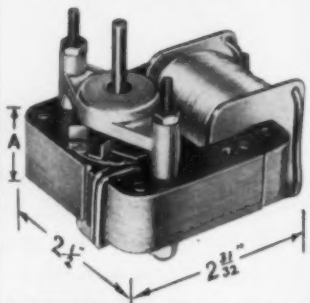
Smooth Power

AC MOTORS

1/1600 H.P. to 1/35 H.P.

MILLIONS

now in use...



PROOF that you can

RELY on GI

Meet an all-around performance champion. GI's husky, versatile Model "A" motor. **Proved dependable millions of times over,** it's the power choice of the nation's great-name manufacturers . . . setting an amazing performance record in countless applications from phonographs to kitchen fans to pumps. If dependability is your aim, Model "A" is your motor!

MODEL "A" two-pole shaded pole motor available in various lamination thicknesses. Precision constructed for reliable, long hard usage. Perfectly balanced for smooth, quiet, operation.

MODEL	HP 2000 RPM	LOCKED TORQUE in./oz.	MAXIMUM TORQUE in./oz.	FREE SPEED RPM	A
A-3-CW A-3-CCW	1/500	0.7	1.1	3360	3/8"
A-4-CW A-4-CCW	1/350	1.0	1.4	3380	1/2"
A-5-CW A-5-CCW	1/180	1.7	2.7	3430	5/8"
A-6-CW A-6-CCW	1/130	1.9	3.3	3430	3/4"
A-7-CW A-7-CCW	1/100	2.1	3.8	3500	7/8"
A-8-CW A-8-CCW	1/90	2.5	4.5	3480	1"
A-9-CW A-9-CCW	1/70	2.7	5.3	3520	1 1/8"
A-12-CW A-12-CCW	1/60	3.0	6.5	3500	1 1/2"
A-14-CW A-14-CCW	1/50	3.1	7.0	3490	1 3/4"
A-16-CW A-16-CCW	1/45	4.0	7.5	3490	2"

Standard shaft diameter .1817, 1/4" shaft available if desired.

Write today for catalog sheet and quantity-price quotations.

THE GENERAL INDUSTRIES CO.

DEPARTMENT GK • ELYRIA, OHIO

DESIGN ABSTRACTS

Plastics As Solid Lubricants and Bearings

Based on present knowledge of friction and wear, mechanism for plastics would seem to be similar to that for metals. They differ in accordance with differences in chemical nature of surface and changes in those bulk properties affecting deformation under specific sliding conditions. This applies particularly to nylon.

In the case of polytetrafluoroethylene, however, an additional factor is involved in sliding—failure at interface rather than in the bulk. But when polytetrafluorocthylene is appreciably heated in use or in test, self-lubricating behavior is diminished to point where it behaves like other plastics. This material retains its superior bulk properties at higher temperatures than other plastics, however.

Usefulness of polytetrafluoroethylene is likely to be extended as its use in new forms is developed.

Abstracted from "Plastics as Solid Lubricants and Bearings," A. J. G. Allan, E. I. duPont de Nemours & Co., Lubrication Engineering, May 1958, 84 E. Randolph St., Chicago 1.

Lubrication Fundamentals

Physical principles of lubrication are reviewed theoretically and experimentally, with considerations limited to a clean film at any one moment, free of deterioration. Work of some of the principal researchers in this field are discussed.

Abstracted from "Fundamentals of Lubrication," M. D. Hersey, U. S. Naval Engineering Experiment Station, Bureau of Ships Journal, June 1958, Navy Dept., Washington 25, D. C.

Welded Joint Design

Design of joints which are to be fusion welded by any of the arc or gas processes, with either manual or machine equipment, are discussed.

Abstracted from "Elements of Joint Design for Welding," K. H. Koopman, Welding Journal, June 1958, 33 W. 39 St., New York 18.

Load in Screw Threads

This critical review of papers on distribution of load includes comments on the work of Sopwith, Atkin, Case, Arnold, Atkins, Buckingham, Stewart, Hill, Hetenyi, Goodier.

Abstracted from "Critical Review of Distribution of Load in Screw Threads," B. H. Vidugiris, Case Institute of Technology, Fasteners, Vol. 13, No. 2, Industrial Fasteners Institute, 1517 Terminal Tower, Cleveland 13.

Failure of Metals Under Load

Some of the investigations carried on in Australia based on the approach of the solid state physicist include: production of ductile chromium; discovery and interpretation of cell formation and grain displacement effects in creep; discovery and explanation of grain boundary cavitation in metals stressed at high temperatures; discovery of crack initiation at intensified slip bands under fatigue conditions.

Abstracted from "Failure of Metals Under Load," Hugh Muir, University of Melbourne, Journal of Australian Institute of Metals, May 1958, Melbourne, Australia.

Metal Cutting

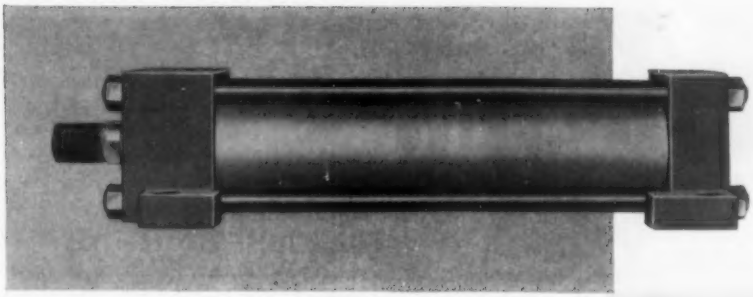
The most widely held opinions on such factors as tool life, productivity, chip formation, cutting temperatures, cutting fluids, finish, experimental work are summarized.

"Abstracted from "What Is Known Today About Metal Cutting," F. W. Boulger, Battelle Memorial Institute, ASTE paper 44, 10700 Puritan Ave., Detroit 38.

Predicting Relay Performance and Reliability

A method of balancing forces by electrical means has been applied to the testing of relays, with direct readout on a conventional X-Y plotter. This system permits prediction of force developed in the moving armature, as a function of ampere-turns applied to relay coil. Force-function curves can be developed that make it possible to determine realistic magnetic and spring tension tolerances.

Abstracted from "Accurate Prediction of Relay Performance and Reliability with Force-function Measurements," T. R. Welch, Telecomputing Corp. Presented at 6th National Conference on Electromagnetic Relays. Copies available from T. C. Components, 9151 Exposition Drive, Los Angeles 34.



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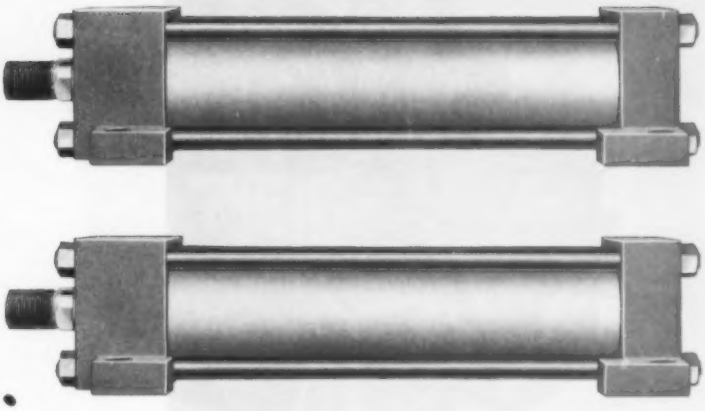

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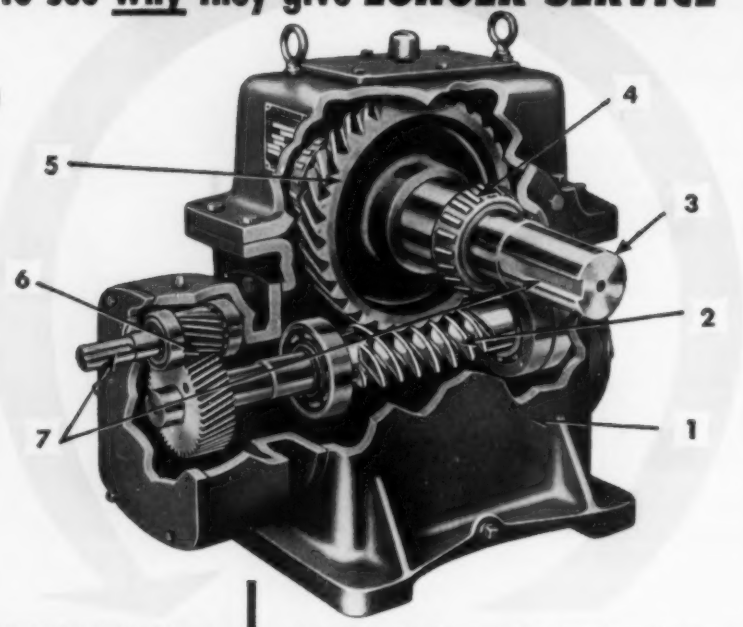

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NEW BOOKS

Information Resources

JESSE H. SHERA, ALLEN KENT and JAMES W. PERRY. *Published by Interscience Publishers, Inc., 250 Fifth Ave., New York.* 8½x11, 214 *pp.* $5.

One of the most imposing roadblocks standing in the path of scientific advancement in the US is our ineffective utilization of recorded knowledge. The Soviet Union, on the other hand, organized its Institute of Scientific information in 1953. Its work in this vital area has been described as "really shattering. No other agency in the world is doing this job." To promote development of an agency in the US which would improve utilization of recorded information, a special meeting of the Council on Documentation Research, sponsored by Western Reserve University, was held last Feb. 3-4.

This book reports on that meeting and is divided into four parts: text of the working paper prepared at Western Reserve, reports on the present status of information services and projected needs of user organizations; summary of meeting and suggested program for action; appendices including transcriptions of discussion—partly verbatim, partly edited.

Basic Feedback Control System Design

C. J. SAVANT, JR., *Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36.* 6x9¼, 418 *pp.* $9.50.

The author attempts to present the material in a practical way first. Theory is not injected until Chapter 4, "The Root-locus Method," and the reader suddenly remembers that feedback control is a complex subject and cannot be simplified significantly.

The Bode and Nyquist methods are discussed, but the root-locus system has been given the most attention Stability calculations, equalization by gain adjustment, multiple loop servos, electromechanical networks, and all necessary mathematical tools are provided. One chapter covers servomechanism transducers, including po-

(Continued on page 119)

tentiometers, synchros, all types of tachometers, force-balance accelerometers, and pressure transducers. Other chapters thoroughly analyze servo components, such as motors, gyroscopes, magnetic amplifiers, and gear trains.

Linearization and other methods to solve nonlinear servo problems are provided. The appendix gives mathematical derivations related to Laplace transforms, classical solutions of transient differential equations, solving of roots, determinants, and certain stability criterion. A complete bibliography and index are included.

ASTM Standards on Light Metals and Alloys

Published by American Society for Testing Materials, 1916 Race St., Philadelphia 3, 6x9, 310 pp. $3.75.

This standard includes not only those specifications and methods of test for light metals and alloys, but also those for light metal alloy diecastings and those for aluminum wire and cable for electrical purposes. Several methods for chemical analysis of metals are also given. Content is divided into two groups; aluminum and aluminum-base alloys; magnesium and magnesium-base alloys. Each group is further subdivided into standards for ingots, castings, bars, rods wire forgings, pipes, plates.

Introduction to Electromagnetic Engineering

ROGERS F. HARRINGTON. *Published by McGraw-Hill Book Co., 330 W. 42nd St. New York 36, 6x9, 320 pp. $8.*

This is a college text in electromagnetic theory—Junior and Senior or first-year graduate level First chapter gives thorough groundwork in basic units and laws of electrical circuits. The introduction encourages one to believe that the text will be simple and everything will be explained for easy study. Actually, previous knowledge of vector analysis, calculus, and some higher math is essential.

The necessary mathematics is given as the subject matter is expanded, so be prepared for vector line integrals, circulation and curl, Maxwell's equations, scale potential integral, wave

(Continued on page 121)

MICRO-BEARING ABSTRACTS

by **A. N. DANIELS**, *President*
New Hampshire Ball Bearings, Inc.

DYNAMIC AND STATIC LOAD RATINGS

Load ratings of MICRO bearings are based on standards established by the Anti-Friction Bearing Manufacturers Association and are the result of extensive tests.

The "life" of an individual bearing is defined as the number of revolutions the bearing makes before the first evidence of fatigue develops. Fatigue, in turn, is a function of bearing load and although other factors, such as contamination and high temperature, affect the life of a bearing, it is assumed that clean bearings running at normal temperatures are being considered.

It is not possible to predict the life of any individual bearing. The problem, therefore, is best approached by a consideration of empirically derived dispersion curves which provide a means of determining bearing life on a probability basis. That is, they permit the average life of a given group of bearings to be accurately specified.

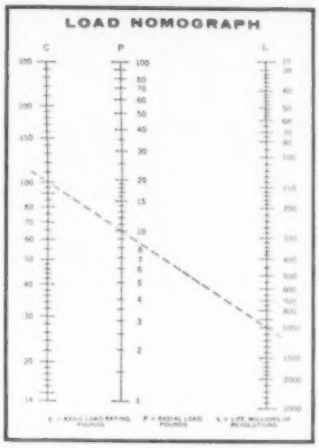
For purposes of standardization, the "rating life" of a group of apparently identical ball bearings is defined as the number of revolutions that 90% of the group will complete or exceed before the first evidence of fatigue develops. This figure is approximately one-fifth of the average life.

If two groups of similar bearings are run under different loads F_1 and F_2 within normal operating range of loading and rpm, their lives L_1 and L_2 are inversely proportional to the cubes of the loads, i.e., The BASIC LOAD RATING C is that radial load which a group of apparently identical bearings can endure for a rating life of one million revolutions, with stationary load and rotating inner ring. Within normal operating ranges, rating life for any load is a constant number of revolutions, so the following relationship, a restatement of the inverse cube proportion, may be used to compute rating life when basic load rating and applied radial load are known:

$$L = \left(\frac{C}{P}\right)^3$$

L=rating life in millions of revolutions
where, C=basic load rating in pounds
P=applied radial load in pounds

The nomograph illustrated permits the quick evaluation of any one of the three quantities when the other two are known. For example, if the C rating of a given bearing is 95 pounds, and the bearing is loaded radially with



12 pounds, P, a straight edge crossing these two values in their respective columns shows that the bearing could be expected to have a life, L, of 450 million revolutions.

"EQUIVALENT LOAD"

Bearings whose loads are primarily radial are usually also subjected to axial forces. When the axial component of the load is greater than a negligible value, this combined radial and thrust load may be expressed in terms of a simple radial load in order that the basic load rating C may be calculated. This simple radial load is known as the "equivalent load", which is that constant stationary radial load which, if applied to a rotating inner ring, would give the same life as that which the bearing will attain under the actual conditions of load and rotation.

A formula for determining "equivalent load" and a more comprehensive discussion of static and dynamic loads is found in our design handbook.

DESIGN HANDBOOK OFFERED FREE

You'll find this new, 70-page authoritative publication a great help in solving problems in designing instruments or small electro-mechanical assemblies.

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Typical cut-away views of instrument-type retainer ball bearings.

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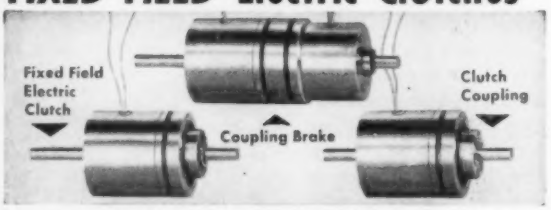

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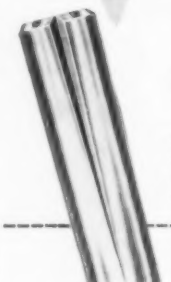

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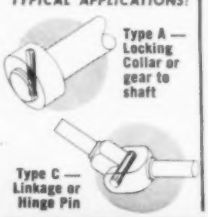

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equations, Poynting's Theorem, guided waves and resonance. There are detailed discussions of charge and current density and intensity, static fields, changing fields, circuit elements, boundary conditions, and all necessary theory to help understanding of electromagnetics. The author suggests supplementary reading, particularly as a followup course. For example, look for texts written from the physicists' viewpoint emphasizing the microscopic (atomic) and force aspects of electromagnetic theory.

Sets of problems are included at the end of each chapter and can be solved from material within the book. Tables of vector relations and some electromagnetic properties of matter are given in appendix.

Electronic Semiconductors

EBERHARD SPENKE. *Published by McGraw-Hill Book Co., 360 W. 42nd St., New York 36. 6x9¼, 402 pp. $11. (Translation by American engineers of the German book Elektronische Halbleiter.)*

The author suggests this book is for the beginner and the somewhat more advanced student . . . but not for the practicing expert who needs (and must find elsewhere) more advanced information on excitons, polarons, plasma interactions, multiple collisions, semiconductor optics, physics of phosphors, photo-effect, and so forth. The book is otherwise quite complete and includes fundamentals of all important semiconductor devices. Impurities in crystals and other phenomena of solid state are covered in theory. For example, there are sections on semiconductor holes, quantum mechanics of the hydrogen molecule, band theories for strongly bound and weakly bound electrons, Zener effects, Fermi statistics, dynamic approach to impurity equilibria, and boundary layers.

Transistors are given thorough treatment. Some covered are: the filamentary; n-p-n; point contact, and unipolar. A 6-page list of symbols provides consistency for the entire text, and translators have successfully Americanized all equations and phraseology. The appendix (13 pp) includes solutions to several useful integrals and shows probabilities of donors and acceptors. A complete bibliography and index supplement the book.

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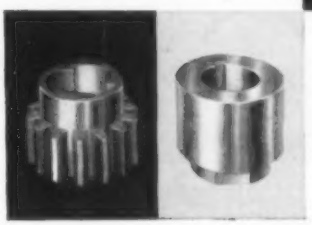

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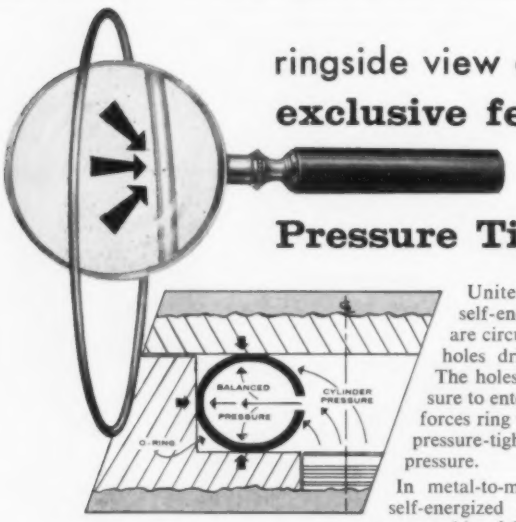

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Selecting Polyphase Motors
Tables match drive-load characteristics with available motor designs in terms of torque, slip and duty cycle. Aug. 18, '58, p. 58. Circle No. E 39

Backlash in Spring Clutches
How two spring modifications can control backlash. Aug. 18, '58, p. 62. Circle No. E 38

Swivel Joints
Guide for choosing between swivels and other flexible connections such as rubber or metal hose. Aug. 4, '58, p. 40. Circle No. E 37

Torque-limiting Devices
Analysis of 17 new and conventional ways to prevent motor overloading and strain on equipment. Aug. 4, '58, p. 50. Circle No. E 36

Time-displacement Records
Mechanical drum recorder offers the simplest way to get T-D records. Comparison between drum camera and its three rivals. July 21, '58, p. 78. Circle No. E 34

Heavy Metal
How high-density alloys may be used to solve design problems involving space and balancing. July 21, '58, p. 62. Circle No. E 33

Stresses in Adhesive Joints
How to calculate stress concentrations of 6 basic joints. July 7, '58, p. 64. Circle No. E 32

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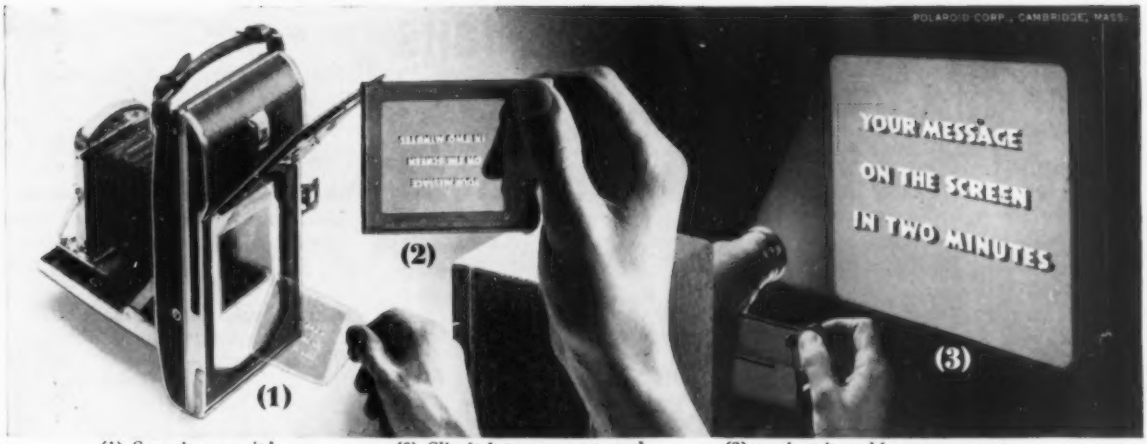
(Continued on page 124)



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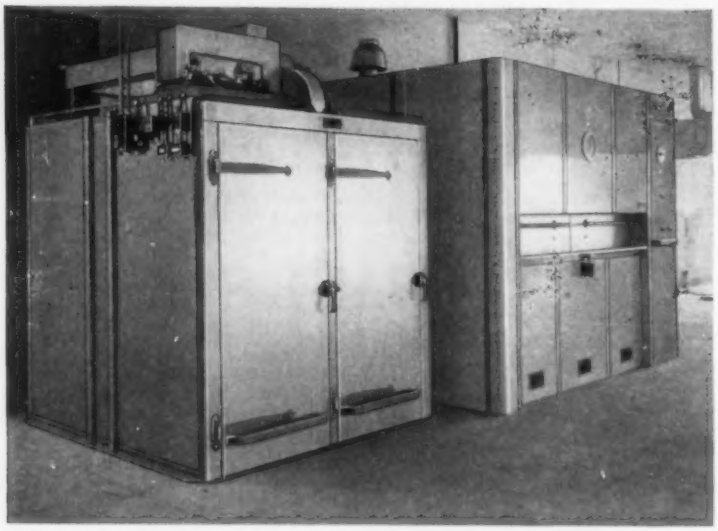

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The 14 most widely specified adhesives, with comparison table. May 26, '58, p. 56. **Circle No. E 26**

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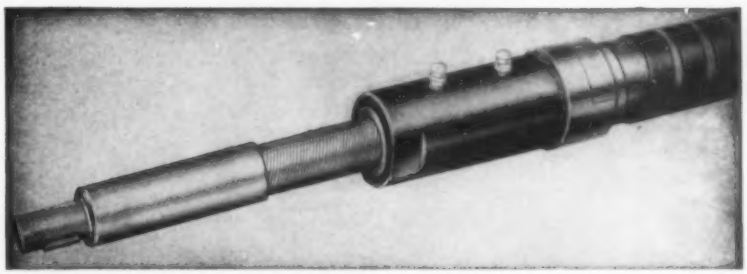
HOW TO SELECT FLEXIBLE SHAFTING FOR POWER DRIVE APPLICATIONS



1¼-inch STOW Power Drive flexible shaft with core assembly pulled out of casing.

For Power Drive applications, the following factors must be considered:

1. Torque (Lb. In.) to be transmitted. (The starting torque should be used in making selections.)

2. Operating Speeds (RPM)—If the maximum speed is higher than the rated speed, torque ratings in the table below do not apply. To find the torque capacity for flexible shafts operating at speeds higher than the rated speeds, multiply the maximum dynamic torque capacity by the rated speed, and then divide by the operating speed. (See example.)

3. Operating Radius—In making the selection from the table below, the radius of the smallest bend in the flexible shaft should be used.

RATINGS—The ratings for flexible shafts shown in the table below apply under the following conditions:

1. when the flexible shaft is adequately supported by clamps along its length. (For unsupported shafts, multiply the calculated torque by a safety factor of 1.6—see example below.)

2. when the flexible shaft is operated in the wind-up direction, which tends to tighten the outer layer of wires. (Flexible shafts operated in the unwind direction will transmit only about 60% of the rated torque.

3. when the flexible shaft is in continuous operation. Note: **the ratings are based on temperature rise. When the operation is intermittent, the ratings in the table may be exceeded. Consult Stow engineers for specific recommendations.**

RATED SPEED R.P.M.	MAXIMUM DYNAMIC TORQUE CAPACITY (LB. IN.) STRAIGHT AND CURVED SHAFTS RADIUS OF CURVATURE IN INCHES									Wgt./ C. Ft.	Core Dia.	Core No. and Type	Shaft Size
	50 to Strgt.	25	20	15	12	10	8	6	5				
4,500	2.4	2.2	2.0	2.0	1.92	1.9	1.7	1.5	1.25	3.0	.124/.128	2049 MH	13
3,800	7.0	6.4	6.0	5.8	5.4	5.0	4.6	3.6	2.0	4.5	.148/.152	2081 MH	15
2,900	9.4	8.6	8.0	7.6	7.0	6.6	6.0	4.8	3.4	7.0	.185/.189	5108 MH	19
2,500	22.0	20.0	18.8	17.6	16.0	15.0	12.6	10.8	9.0	12.5	.247/.252	8924 MH	25
1,800	30.0	28.0	26.4	25.0	23.0	21.0	18.0	14.0		20.0	.308/.313	8925 MH	31
1,800	33.8	31.5	29.7	28.1	25.9	23.6	20.2	15.8		20.0	.308/.313	8969 T	31
1,800	36.0	33.0	31.6	30.0	28.0	26.0	22.0	18.0	11.0	21.0	.324/.329	2034 A	31
1,500	80.0	66.0	63.0	58.0	51.0	46.0	37.0	22.0		28.5	.368/.374	2035 A	38
1,500	60.0	54.0	50.0	46.0	42.0	38.0	30.0	24.0		29.0	.387/.393	8970 MH	40
1,500	90.0	81.0	75.0	69.0	63.0	57.0	45.0	36.0		29.0	.387/.393	8971 T	40
1,150	136.0	110.0	104.0	94.0	80.0	72.0	56.0			50.5	.497/.503	8999 A	50
1,150	148	124	110	92	72	56				53.5	.505/.511	6940 T	50
900	248	200	176	124	84					78.5	.610/.618	6997 T	63
900	220	204	192	180	152	130				80.5	.630/.638	7731 A	63
750	340	224	156	76						117	.747/.753	2056 T	75
600	760	520	420							205	.998/1.004	2057 T	100
440	1,500	720								343	1.298/1.304	2058 T	125

EXAMPLE—How to use the table:
The problem is to transmit ½ HP at 1700 RPM through an unsupported flexible shaft in a 25" radius, estimated starting torque 150% of normal operating torque.

1. Calc. Torque (lb. in.)—
$$\frac{HP \times 63000}{RPM} = \frac{.5 \times 63000}{1700} = 18.5$$
2. Correction factor for starting torque 1.5 x 18.5 = 27.75
3. Correction factor for unsupported shaft 27.75 x 1.6 = 44.4 lb. in.
4. Refer to Table above. Read downward in column under 25" radius until you find a core having a rating of at least 44.4 lb. in. In this case we find that core No. 8970 is rated 51 lb. in. at 1500 RPM. Since the given speed is 1700 RPM, multiply 54 by 1500 and divided by 1700. 54 × 1500 ÷ 1700 = 47.6 lb. in. (rated torque at 1700 RPM). Therefore, Core No. 8970 is correct.

For Engineering Bulletin No. 570 and a free torque calculator, write

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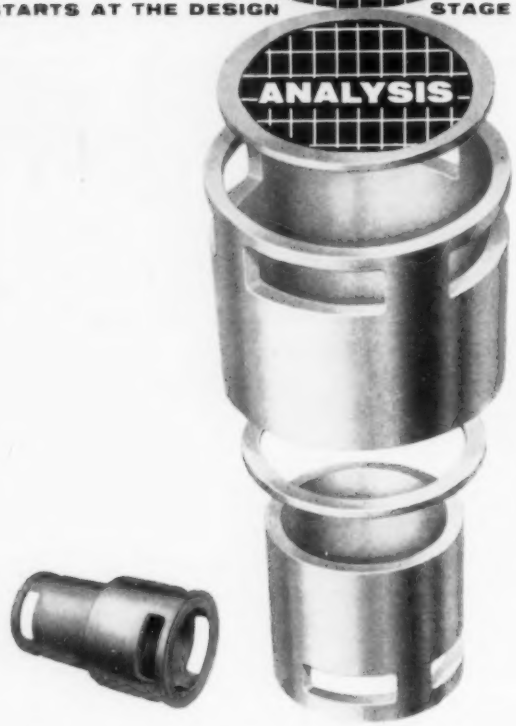

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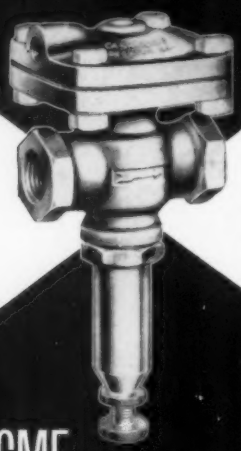

Type Vacuum Regulator Valve D-51

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To keep pace with fantastic demands for filter tipped cigarettes (now 40% of the market), manufacturers are attaching a new kind of tipping device to machines — capable of tipping 780,000 cigarettes in a 10-hour run.

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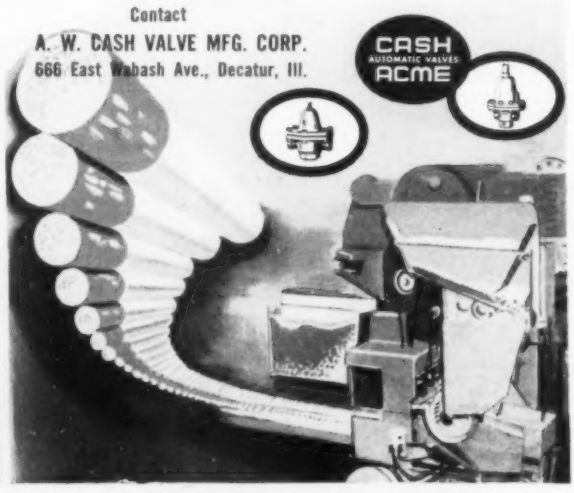

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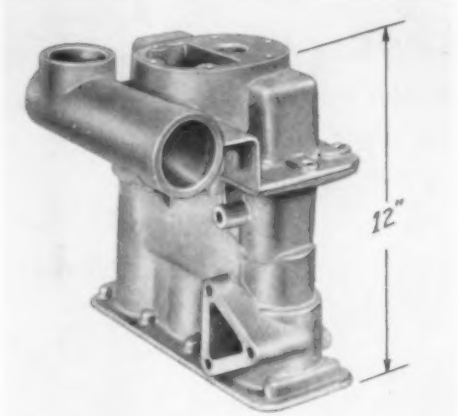

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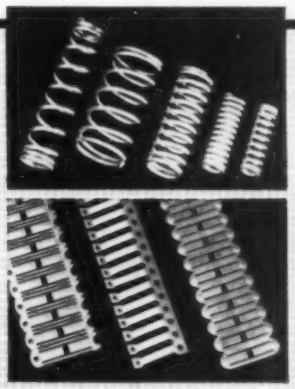

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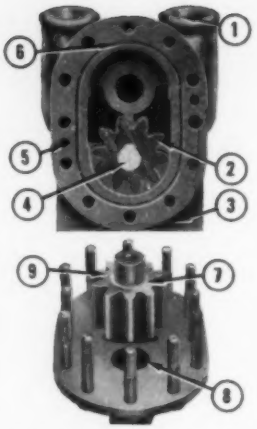

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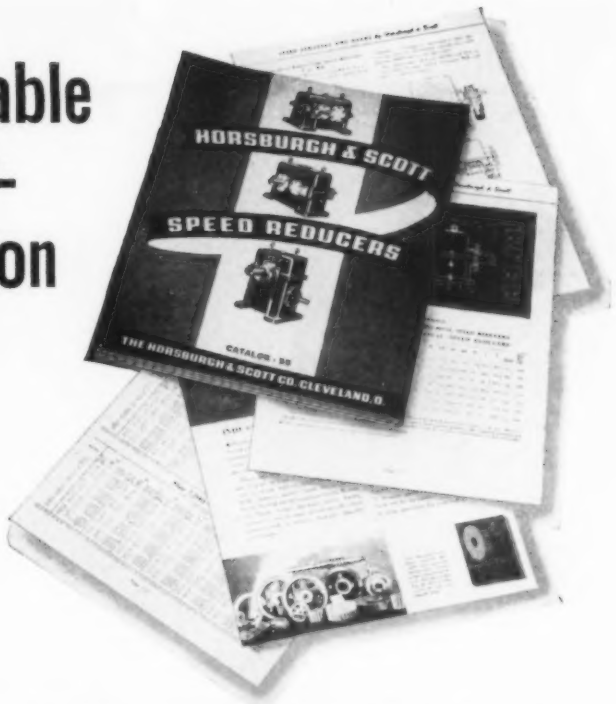

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- New ratios and ratings for Worm Helical Speed Reducers shown.
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- New Rating Tables—more complete than ever before—easier to use.
- Engineering Data Section—more tables and data you want.

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5112 Hamilton Avenue
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Add them up and you have the makings of another big upswing. Wise planners, builders and buyers will act *now* to get ready for it.

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Your Great Future in a Growing America

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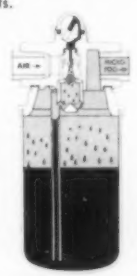
AUTOMATIC LUBRICATION NEWS

How a Lubricating Fog for Bearings CUTS COSTS for Lubricant, Maintenance and Down-time

Better Lubrication

MICRO-FOG lubrication automatically coats all the bearings, gears, chains and other components of a machine with a continuous, protective film of clean oil. Just the right amount of oil is applied to provide the most efficient lubrication, reducing wear on machine components and cutting maintenance and replacement costs.



MICRO-FOG Principle

Oil Always Fresh, Always Clean

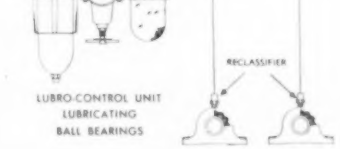
There is no recirculation of deteriorated or contaminated lubricant to cause wear or corrosion. Clean oil is applied continuously to all lubrication points in carefully metered amounts.

For Large and Small, Plain and Anti-Friction Bearings

MICRO-FOG Lubricating systems have found enthusiastic acceptance for use on all types of machinery. Actual applications range from dental drills with 3/32" bearings turning at 300,000 rpm to huge roll mill bearings on shafts as large as 34" in diameter, turning at 50 rpm.

Centralized, Automatic Lubrication

A single, MICRO-FOG Lubricator will automatically deliver enough airborne lubricant, proportionately distributed to completely lubricate a small or a large machine tool. Only one lubricator to maintain and refill.



Big Savings in Lubricant

Carefully metered quantities of oil are applied to each lubrication point. MICRO-FOG provides more thorough lubrication using only a few ounces of oil per day than other methods using several gallons of oil per day.

Bearings Run Cooler

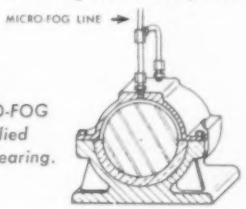
Air passing through the bearing carries away heat, and there is no pool of lubricant in the bearing to generate heat as a result of fluid friction. Lubrication is continuous—there are no periods of insufficient lubrication with metal wearing on metal.

Contaminants Excluded From Bearings

A slight positive pressure is maintained within the bearing housing, preventing the entrance of contaminants from the surrounding atmosphere.

Oil Filters, Sumps and Pumps Eliminated

There is no need to reclaim or recirculate because of the small quantity of lubricant used in MICRO-FOG Lubrication Systems. Expensive high pressure piping is also eliminated. Fewer bearing seals are required.



How MICRO-FOG is applied to a bearing.

Automatic Alarm Controls

MICRO-FOG Lubricators are available with automatic control devices to actuate an alarm system or controls as a warning of conditions affecting proper lubrication.

Visible and Adjustable Oil Feed

The oil feed is readily visible and adjustable on all models of MICRO-FOG Lubricators, offering proof that the lubricator is operating.

A MICRO-FOG Lubricator For Every Size Machine

20 Models to choose from—ratings up to 1,000 bearing inches and oil reservoir capacities up to 4½ gallons.

For all your air line filter, regulator and lubricator needs, call your nearby Norgren Representative, or WRITE FOR Descriptive Literature.

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the conveying of liquids, gases or granular solids . . .

Specify Flexon Hose

in rubber, synthetic or metal

FLEXON RUBBER AND SYNTHETIC HOSE AND COUPLINGS

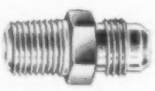
Flexon Bulk Hose is offered in a complete range of types and sizes up to 2" for automotive, aircraft and industrial services.

Flexon Hose Assemblies are furnished with the broadest choice of standard and special fittings for low, medium and high pressures.

Flexon Reusable Fittings save time and money. All are equipped with Easy Grip Hex on stem for safe, speedy insertion into hose without the use of special mandrels.

Flexon Crimped-on Fittings are factory attached to provide complete hose assemblies to your specifications.

Flexon Dynalock Fittings are the ultimate in a clamp type reusable fitting.



Flexon Adaptors, Unions & Connectors are available in a complete range of sizes and types for all services.

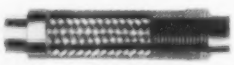
FLEXON METAL HOSE AND COUPLINGS

Flexon Corrugated Hose is the standard of the industry. Available in a variety of types in stainless steel, steel, bronze and other alloys.

Flexon Convoluted Hose is made in all commonly used types — interlocked, square locked, double groove — in all suitable metals.

Flexon Metal Hose Assemblies combine industry proven hose and couplings into a wide range of standard and special units.

Flexon Moisture Resistant Conduit combines a synthetic cover with a metal liner to form flexible electrical conduit.



Flexon Vibra-Sorbers are standard assemblies for absorbing vibration in refrigeration system tubing or piping.

Flexon Metal Hose Couplings are made in a complete range of sizes and styles for all types of Flexon Metal Hose.

Full information on Flexon Hose is given in these bulletins: Bulletin 170 covers metal hose; bulletin C-100 covers rubber hose. Ask for your copies.

• Flexonics Corporation is your headquarters for hose connections. As manufacturers of the broadest range of hose connectors and with over 56 years manufacturing experience, Flexonics is particularly well qualified to help you in your application problems. Whenever you have a problem that may be solved by the use of hose, let Flexonics Application Engineers assist you. Just send an outline of your requirements.

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E26. Sandwich-panel Adhesives
The 14 most-specified adhesives compared. (5/26/58)

E27. Lubricating Ball Bearings
42 oils and greases for instrument bearings. (6/9/58)

E30. Design for Automatic Production
For small as well as large quantities. (6/23/58)

E31. Designing with Cantilever Springs
Equations for 7 types shows how to triple energy capacity. (7/7/58)

E32. Stresses in Adhesive Joints
How to calculate stress concentrations of 6 basic joints. (7/7/58)

E33. Heavy Metal
How high-density alloys may be used to solve design problems involving space and balancing. July 21, '58.

E34. Time-displacement Records
Mechanical drum recorder offers the simplest way to get T-D records. July 21, '58.

E35. PE Editorial Index—Jan.-June 1958

E36. Torque-limiting Devices
Analysis of 17 new and conventional ways to prevent motor overloading and strain on equipment. (8/4/58)

E37. Swivel Joints
Guide for choosing between swivels and other flexible connections such as rubber or metal hose. (8/4/58)

E38. Backlash in Spring Clutches
How spring modifications can control backlash. (8/18/58)

E39. Selecting Polyphase Motors
Tables match drive-load characteristics with available motor designs in terms of torque, slip and duty cycle. (8/18/58)

Description of New

GENERAL ENGINEERING

3—Square Root Integrator
13—Measures Multiple Pressures
26—Fireproof File
27—Semi-automatic Whiteprinter

POWER TRANSMISSION

4—Quadruple Reduction Drive
7—Worm and Planetary Gear
10—Miniature Gear Boxes
21—Adjustable Speed Drive

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34—Corrosion Control, 8 pp, A M Byers Co.

42—Cold-finished Bars, 4 pp, T Ryerson & Son, Inc.

NON-METALLIC MATERIALS, FINISHES

28—Planned Lubrication, 20 pp, Keystone Lubricationg Co.

POWER TRANSMISSION

36—Adjustable Speed Drives, 12 pp, Cutler-Hammer, Inc.

MECHANICAL PARTS

30—Casters and Wheels, 44 pp, Albion Industries, Inc.

31—Vibration Mounts, 16 pp, Lord Mfg Co.

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Components and Materials Appearing on Pages 87-106

FASTENING AND JOINING

6—Self-insulating Fasteners
11—Lock Washer Terminals

ELECTRICAL, ELECTRONIC COMPONENTS

2—Miniature Magnetic Switch
5—Miniature Panel Lights
8—Tapped Transformers
17—0.06 oz Basic Switch
16—Transistorized Flasher
22—High-temperature Switch

HYDRAULIC, PNEUMATIC EQUIPMENT

1—Thin Solenoid Valves
12—Pump and Motor
19—Foot-mounted Valves
20—Foot-operated Poppet Valves
25—Miniature Thermal Relief Valve
23—Valve-operated Cylinders
24—High-pressure Valves

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9—Air-braking Systems
14—Solid-state Counter
15—Actuator Indicator Rod
18—Non-linear Potentiometer

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Bulletins (p. 110-114)

FASTENING AND JOINING

40—External Votters, 1 pp, Hunter Spring Co.

MOTORS, ENGINES AND CONTROLS

33—DC Miniature Motors, 10 pp, Globe Industries, Inc.

37—Torque vs RPM, chart, John Oster Mfg Co, Avionic Div.

41—FHP Motors, 4 pp, Howard Industries, Inc.

ELECTRICAL, ELECTRONIC COMPONENTS

38—Continuous Strip Electrical Terminals, 16 pp, Kent Mfg Corp.

HYDRAULIC, PNEUMATIC EQUIPMENT

32—Hydraulic Cylinders, 12 pp, Lynair Inc.

29—Selecting Steam Traps, 40 pp, V D Anderson Co.

39—Hydraulic Cylinders, 3000 to 3000 PSI, 8 pp, Milwaukee Cylinder Co.

43—Variable Displacement Pump, 4 pp, Oilgear Co.

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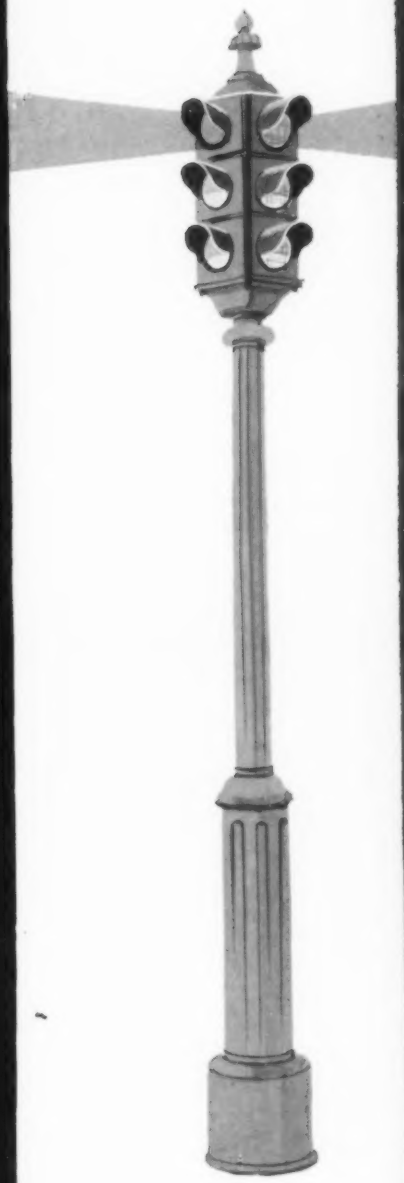

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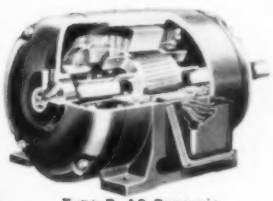

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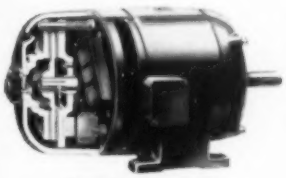
ROLLING STOP... Master Type D Dynamic Unibrake Motors. Braking is obtained with a unique, patented brake winding superimposed on the stator winding. Simple, compact, with no DC current required, the brake has no moving parts. There is nothing to wear or adjust... braking torque repeats consistently. Particularly recommended for automatic applications where static holding is not desired. Sizes ¼ to 30 H.P.

MASTER UNIBRAKE MOTORS



Type M—Magnetic

STOP-HOLD... Master Type M Magnetic Unibrake Motors. For quick, controlled stopping... especially when you want to hold the load. Spring-setting magnetic brakes of the friction disc type combine with motor in a compact, integral unit. Sizes... ⅛ to 150 H.P.

MASTER GEARMOTORS and variable speed drives can be furnished with Unibrakes, too. See Master for the perfect power drive for you.

THE MASTER ELECTRIC CO.

DAYTON 1, OHIO

DIVISION OF RELIANCE ELECTRIC AND ENGINEERING CO.

3 new applications get longer life and minimum maintenance using Dodge pillow blocks with Timken® bearings

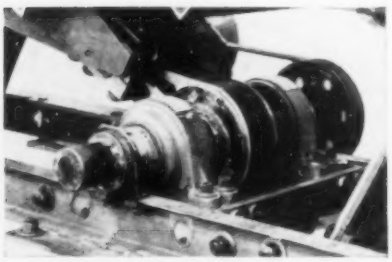
PICTURED below are three applications where Timken bearing equipped Dodge pillow blocks stay on the job with little attention under tough conditions. Their tapered design lets Timken® bearings take *both* radial and thrust loads in any combination. And full-line contact between rollers and races provides extra load-carrying capacity. Wear is reduced, maintenance is cut to the minimum.

Cutaway view shows the Dodge All-Steel pillow block with Timken bearing mounting. Of special design, the bearing has a tapered bore with self-aligning spherical outer surface —never needs adjustment.

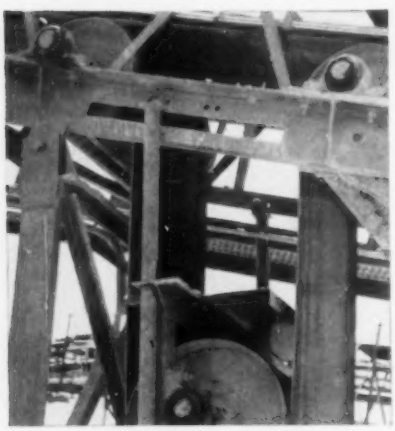
Besides the All-Steel pillow block, other versatile Dodge pillow blocks with Timken tapered roller bearings are: Type "E", Double-Interlock, Type "C" and Special Duty. All are compact in design. Special thrust devices that take up extra space are not needed.

And to get the finest steel for Timken bearings, we make it ourselves—America's only bearing manufacturer that does. So specify bearings trademarked "TIMKEN" for the machines you buy or build. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

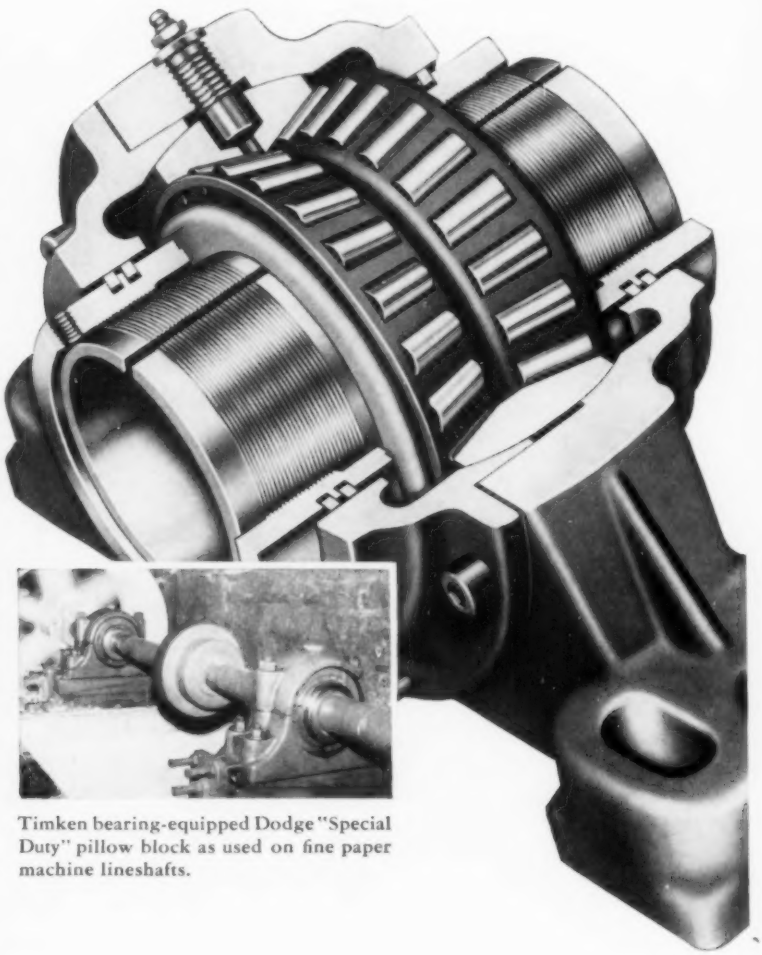
This symbol on a product means its bearings are the best.



Timken bearing-equipped Dodge All-Steel pillow block used in a vibrating conveyor.



Timken bearing-equipped Dodge Type "E" pillow block used in sand and gravel plant.



Timken bearing-equipped Dodge "Special Duty" pillow block as used on fine paper machine lineshafts.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD